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ABSTRACT

The objectives of this workshop, jointly sponsored by the State Education Commission of the People's Republic of China and the International Institute for Educational Planning (IIEP), were to: discuss the problem of the relationship between the development of higher education, industrial growth, and technical change; analyze the growth of the industrial sector and the expansion of higher education and note their effects on the structure of qualified manpower and the educational profile of the working force; introduce some technical aspects of higher education planning; and discuss different organizational problems (particularly the relationships between various levels of educational decision making and between institutions of higher education and the industrial sector). The workshop focused on integrated planning of higher education and industrial development, a theme pertinent to the ongoing reforms of higher education in China and the current concern for rapid modernization. An effort was made to apply various active training methods during the workshop and to encourage participation by the 38 attendees (mostly officials responsible for higher education planning at a provincial level). Copies of the 13 lectures and 8 practical exercises are provided. The three appendices include the program of the workshop, the list of participants, and a list of resource persons. Tables and graphs are included. (SM)

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Industrial development and the planning of higher education

Report of an IIEP workshop

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Dalian
People's Republic of China
3-20 June 1986

IHE 021 455

International Institute for Educational Planning

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Industrial development and the planning of higher education

Report of an IIEP workshop
held at Dalian, People's Republic of China
3-20 June 1986

International Institute for Educational Planning
(established by Unesco)

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Introduction

The National Workshop on Industrial Development and the Planning of Higher Education, organized by the Educational Planning and Financing Department of the State Education Commission of the People's Republic of China, in co-operation with the International Institute for Educational Planning, Unesco's Educational Planning and Policy Division and the Unesco Regional Office of Education for Asia and the Pacific, was held at the Dalian Institute of Technology from 3 to 20 June 1986.

I. Objectives

The objectives of the workshop were:

- to discuss the general problem of relationship between the development of higher education, industrial growth and technological change;
- to analyze, in one province, the growth of the industrial sector, the expansion of higher education and their effects on the structure of qualified manpower and the educational profile of the working force;
- to introduce various technical aspects of higher education planning such as projections of qualified manpower requirement, projections of enrolment and graduates in higher education, projection of resource needs and allocations to different types of institutions of higher learning;
- to discuss various organizational problems especially the relationships: (i) between different levels of educational decision-making: State Education Commission, Specialized Ministries, Provinces and Institutions, and (ii) between institutions of higher education and the industrial sector.

II. Content of the workshop

As implied by its main theme and the profile of the participants, the focus of the workshop was on integrated planning of higher education and industrial development. This theme has particular relevance to the on-going reforms of higher education in China and to the present concern for rapid modernization. It also fits into the socialist context of close relationships between qualified manpower planning and higher education planning.

The detailed programme of the workshop is presented in Appendix A.

III. Participants

Thirty eight participants attended the workshop. Most of them were officials responsible for higher education planning at provincial level (24), in autonomous territories (3), in large cities with autonomous planning functions (7) and in other institutions (4).

The detailed list of participants and their functions is presented in Appendix B. The list of resource persons is given in Appendix C.

IV. Training methods

A particular effort was made to apply active training methods, encouraging participation by all concerned. In order to allow for a more in-depth discussion of the themes of the workshop, and in order to facilitate practical work and hands-on practice with micro-computer simulation models, the participants were divided into five groups based on geographic criteria:

GROUP I: East China (Anhui, Fujian, Jiangsu, Jiangxi, Shandong and Zhejiang Provinces, and Shanghai municipality)

GROUP II: South China (Guangdong, Guangxi, Henan and Hunan Provinces, and Guangzhou and Wuhan municipalities)

GROUP III: North East China (Heilongjiang, Jilin, Liaoning Provinces, Shenyang, Dalian and Harbin municipalities)

GROUP IV: North West China (Gansu, Ningxia, Shaanxi, Sichuan, Xinjiang Provinces, and Chongqing and Xian municipalities)

GROUP V: North China and South West Provinces (Hubei, Shanxi, Tienjin, Guizhou, Yunnan, Inner Mongolia and Tibet)

It was thus possible, during the workshop, to vary the teaching methods: Team Teaching in plenary sessions, group discussions on specific themes, practical work sessions using micro-computers. Regarding the practical sessions, the availability of micro-computer equipment at the Dalian Institute of Technology, where the training workshop took place, made it possible to introduce the participants to the use of computers and to demonstrate how existing softwares (such as Lotus 1,2,3 or dBase III) can be used in different analysis and projection techniques for educational planning.

When required, the participants had access to a specialized room where 20 micro-computers were at their disposal. Three simulation models were prepared so that the participants could familiarize themselves with their use.

- The first one dealt with qualified manpower projections and was meant to simulate and show the effect of different economic growth alternatives on qualified manpower requirement.

- The second one dealt with enrolment and graduates projections and allowed to simulate the results of different admission policies on the trends of enrolment and on the number of graduates and to compare these with the needs for qualified manpower.

- The third one related to the projection of costs of higher education, taking into account the student/teacher ratio, the structure of teaching force (professors, associate professors, lecturers, assistants and instructors), the salary level of different categories of teaching staff and certain standard expenditures such as the costs of teaching materials and equipment and boarding costs.

The equations used in the models, the assumptions on which they were based, were clearly presented to the participants so that they may assess the usefulness and the limits of these simulation models. This could not have been achieved by a theoretical and abstract presentation.

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Part I
Lectures

Lecture 1

Research, technological development and industrial development

by Sylvain Lourié

Objective of the presentation

This presentation will first focus on various sets of inter-relationship prevalent in selected "developed" and "developing" countries:

- Economic growth and industrial development.
- Industrial and technological development and research.

It will then attempt to draw lessons from the Chinese experience and raise issues for investigation and analysis

Economic growth and industrial development

As most generally understood, production covers that part of human activity which results in the creation of goods and services suitable for the satisfaction of individual or collective wants.

Gross Domestic Product (GDP) means for a given country, the *total sum* of goods and services produced by all nationals of that country for the year under review. It includes the three Production Sectors: Agriculture, Industry and Services. The first (Agriculture), concerned with the direct products of natural surroundings includes Fisheries, Forestry, Cattle Production and may also cover Mining and Quarry; the second (Industry), concerned with transformation of basic natural products includes Heavy and Light Production (capital and manufactured goods) and Construction while the third (Services) generally includes Public Utilities (Water, Electricity), Transport, Telecommunications, Administrative, Commercial and Financial Services as well as the Information sub-sector (including computer use and services). The gradual growth of the latter sub-sector leads some to consider that in the future it may become the key growth sector. (In 1950, 17% of the economically active population in the USA worked in information occupations—30 years later they numbered 65%).

A measure of a country's economic growth is given by the distribution of GDP by sectors. As a country develops economically its production shifts from Agriculture which in the early stages of development represents a significant share of total National Production to Industry and to Services. The latter is also an indication of urban growth as it is in the cities that all types of services tend to grow (organized either in firms or 'formal' structures or on an individual unstructured or 'informal' basis).

Table 1 shows the relative distribution of Agricuiture and Mining (Primary Sector), Industry (including Manufacturing, Construction, representing the Secondary Sector) and

services (including Electricity, Transport and Services and making up the Tertiary Sector) between India and China on the one hand, and those two countries and other Low-Income Countries, Lower Middle-Income Countries and Upper Middle-Income Countries, listed in the footnote.

This international comparison of production structure expressed in percentage of GDP and indicating broad sectors reflects the fact that as countries move from the "low income" to "middle income" and "upper income" we note that the share of Agriculture goes down as the combined share of Industry and Services increases. The more 'developed' the country, the higher the productivity of Agriculture and hence the smaller its share as a traditional sector while industry and services expand as the 'modern' sectors.

We will now look at China's relative position (compared to selected countries, some from the developing group and others from the developed or industrialized group) in terms of its overall growth rates (gradual expansion of GDP over the years) and, specifically of the industrial sector's. *(See Table 2)*

For the years 1965 to 1973 selected countries from the Low-Income Economies, Middle-Income Economies, Upper Middle-Income Economies, High Income Oil Exporters and Japan show that while overall economic growth was relatively high, industrial growth was even more rapid in all countries listed in the Table except India and USA. For the years 1973-1983 we must note that for countries with a continued expansion of industry (India, China, Philippines, Thailand, Korea, Japan) economic growth is maintained while the others, except Pakistan, seem to show that as industrial expansion rate decreases so does overall economic performance. In both cases this may be essentially explained by the historically significant role of industry as the 'engine' of emerging modern economies.

Industry is a large consumer of energy and although as economic activity emphasis moves from Industry to Information, energy is less in demand and its consumption becomes less meaningful as a growth indicator, it seems interesting to compare energy consumption per inhabitant, expressed in kgs. of oil equivalent, between different countries over an almost 20-year period. *(See Table 3)*

Comparing it to the previous table (Table 2), this table reflects the role of energy not only as a key factor of industrial production growth (consumption by industries lead to production of goods) but of standards of living by population using its various forms for their everyday existence (heating, cooking, transport, etc.). But, in turn, these forms were produced by Industry (Central Heating Furnaces and Equipment, Central Electricity or Gas Ovens, Ships, Automobiles, Trains, Airplanes, Rockets, etc.). In short, the industrial ability of a nation is a necessary—although perhaps not sufficient—condition for growth and therefore, for development. Energy is a useful determinant of the growth rate as well as of the introduction of more advanced forms of technology.

Industrial and technological development and research

Industrial growth does not just happen. Emerging national economies may purchase ready-made industrial potential and import full-fledged plants equipped to the last detail and ready to operate at the turn of a key to start off the first motor which will ignite the production process. These are known as "turn-key operations".

Table 1

International comparison of production structure (Broad Sectors) (% of GDP)

	China	India	OLI (a) countries	LMI (a) countries	UMI (a) countries	Predicted values for large countries around 1980/81		
	1981	1979/80	1982	1982	1982	$300	$850	$2 500
Agriculture	35.8	35.1	44	23	11	35	24	13
Mining	10.8	1.5				6	6	5
Manufacturing	24.5	18.1	16	35	41	13	19	25
Construction	4.7	5.1				5	6	7
Electricity (b)	2.6	1.7				6	7	8
Transport	4.4	5.7	40	42	48			
Services	17.2	32.8				35	38	42
Total	100.0	100.0	100	100	100	100	100	100

(a) OLI - Other low-income countries (excluding China and India).
LMI - Lower middle-income countries.
UMI - Upper middle-income countries.
(b) Includes gas and water for countries other than China (where these activities are in manufacturing).

Low-income economies China and India Other low-income Sub-Saharan Africa	Middle-income economies Oil exporters Oil importers Sub-Saharan Africa	Upper middle-income	High income Oil exporters
	Lower middle-income		
1 Ethiopia	36 Senegal	73 Jordan	95 Oman
2 Bangladesh	37 Lesotho	74 Syrian Arab Rep.	96 Libya
3 Mali	38 Liberia	75 Malaysia	97 Saudi Arabia
4 Nepal	39 Mauritania	76 Chile	98 Kuwait
5 Zaire	40 Bolivia	77 Brazil	99 United Arab Emirates
			Industrial market economies
6 Burkina	41 Yemen PDR	78 Korea, Rep. of	100 Spain
7 Burma	42 Yemen Arab Rep.	79 Argentina	101 Ireland
8 Malawi	43 Indonesia	80 Panama	102 Italy
9 Uganda	44 Zambia	81 Portugal	103 New Zealand
10 Burundi	45 Honduras	82 Mexico	104 Belgium
11 Niger	46 Egypt, Arab Rep.	83 Algeria	105 United Kingdom
12 Tanzania	47 El Salvador	84 South Africa	106 Austria
13 Somalia	48 Ivory Coast	85 Uruguay	107 Netherlands
14 India	49 Zimbabwe	86 Yugoslavia	108 Japan
15 Rwanda	50 Morocco	87 Venezuela	109 France
16 Central African Rep.	51 Papua New Guinea	88 Greece	110 Finland
17 Togo	52 Philippines	89 Israel	111 German, Fed. Rep.
18 Benin	53 Nigeria	90 Hong Kong	112 Australia
19 China	54 Cameroon	91 Singapore	113 Denmark
20 Guinea	55 Thailand	92 Trinidad & Tobago	114 Canada
21 Haiti	56 Nicaragua	93 Iran, Islamic Rep.	115 Sweden
22 Ghana	57 Costa Rica	94 Iraq	116 Norway
23 Madagascar	58 Peru		117 United States
24 Sierra Leone	59 Guatemala		118 Switzerland
25 Sri Lanka	60 Congo, People's Rep.		
			East European Non-market economies
26 Kenya	61 Turkey		119 Hungary
27 Pakistan	62 Tunisia		120 Albania
28 Sudan	63 Jamaica		121 Bulgaria
29 Afghanistan	64 Dominican Rep.		122 Czechoslovakia
30 Bhutan			123 German Dem. Rep.
31 Chad	65 Paraguay		124 Poland
32 Kampuchea, Dem.	66 Ecuador		125 Romania
33 Lao PDR	67 Colombia		126 USSR
34 Mozambique	68 Angola		
35 Viet Nam	69 Cuba		
	70 Korea, Dem. Rep.		
	71 Lebanon		
	72 Mongolia		

Sources: Appendix Table C.5; World Development Report 1984, Indicators Table 3; Technical Notes on the Sixth Plan of India, 1980-85, Planning Commission, the Government of India, June 1981.

Table 2

Growth of Production

	G.D.P.		Industry	
	1965-1973	1973-1983	1965-1973	1973-1983
Low Income Economies				
India	3.9	4.0	3.7	4.3
China	7.4	6.0	9.1	8.4
Pakistan	5.4	5.6	12.4	5.3
Middle Income Economies				
Philippines	5.4	5.4	7.4	6.4
Thailand	7.8	6.9	9.0	9.0
Upper Middle Income				
Korea	10.0	7.3	18.4	11.2
Algeria	7.0	6.5	9.1	6.4
High Income Oil Exports				
Saudi Arabia	11.2	6.9	13.3	3.9
Industrial Market Economies				
United Kingdom	2.8	1.1	2.1	-0.3
Japan	9.8	4.3	13.5	5.5
U.S.A.	3.2	2.3	2.8	1.2
East European Non Market				
Economies				
Hungary	6.1	3.7	6.5	4.4

Or, national economies may purchase industrial licenses or 'know-how' together—or without—the foreign personnel.

But, most determinant is the ability of an economy to launch its *its own* industrial processes through the discovery of new techniques as the Energy Consumption Table (Table 3) helps to suggest. In other words, modern nations as their economies progress tend to own or at least control the means of transforming the matter into the awaited finished product. These innovations in new techniques and improvements of old ones are part of the overall Technological Development of a country. Technological change may be formally defined as 'the application of theoretical and practical knowledge to production through a sequential succession of techniques'. Such an application will alter the make-up of the labour force since technological change is basically a labour-savings process leading to output rise or, in other words, to productivity increase.

Table 3

Energy consumption (1965-1983): an international comparison

	1965	1983
India	100	182
China	170	455
Pakistan	136	197
Philippines	160	252
Thailand	80	269
Korea	504	2 093
Algeria	226	982
Saudi Arabia	1 759	3 536
United Kingdom	3 481	3 461
Japan	1 496	2 929
USA	6 586	7 030
USSR	2 603	4 505

Source: World Bank, "World Development Report, 1985", Table 8, p. 188.

But such technological changes initiated nationally can only exist if prior research and testing have taken place.

Research, which can start modestly in the form of a laboratory experiment or an equation written on a blackboard, can eventually lead to a vast and varied number of applications. This has been the case with fundamental research carried out on the structure of atomic nuclei, which led to the discovery of nuclear energy. Research on solid state physics has radically transformed or created an immense range of products and systems such as digital watches, television receivers, video-recorders, health care equipment and many other familiar products. Space research programmes have yielded many valuable benefits in fields such as telecommunications, remote sensing, new materials, and transport systems. The theoretical understanding of the part played by the nucleic acids in the transfer of genetic information arose from the discovery of DNA but also promises a vast range of applications in the field of biotechnology, from health to food.

Incorporation of microprocessors into existing technologies can produce a generation of new products of improved performance. Advances in information technology combined with progress in computers, video-recorders, and telecommunications can transform education, increase the efficiency of organizations, and permit better use of human and material resources.

Robotics, whose development is seen by some as aggravating an already serious unemployment situation, instead can free workers from hazardous and repetitive labour and can improve the productivity of industry. The same technology can be applied to the problems of the physically handicapped to produce artificial limbs and other devices that may help them.

Remote sensing can improve our capacity to protect our environment and to live in harmony with it, develop our natural resources, and predict our weather. Improvements in materials can create new technologies and enhance existing ones. The evolution of catalysis from an art to a science and improvements in membrance technology offer the possibility of new and more efficient chemical processes. Biotechnology has vast potential for the production of pharmaceutical products such as insulin, the synthesis of industrial chemicals, the development of new agricultural species and the more efficient recovery of mineral resources.

In the field of energy, fast breeder reactor technology will soon offer a major increase in the efficiency of electricity generation from uranium. In the longer term, thermonuclear fusion, one of the most challenging technologies ever conceived, may offer a virtually inexhaustible source of energy from ordinary seawater.

Technologies being applied today are founded upon the scientific research and development of yesterday. Hence, the well-being of society in the next century will rest on the application of scientific research which is being carried out now.

The importance of fundamental scientific research in the birth of new industries cannot be over-emphasized. Vital to this aspect of development is the role of government support of science to inspire the future economic and social development of all countries.

Before looking at the case of China it seems important to recall that the 'purchase' of technology from abroad by developing countries has often put them in great difficulty as, in exchange, they could offer nationally grown or extracted basic commodities, the relative price of which has decreased when compared to the rising cost of imported machinery on turn-key plants, for example.

From the point of view of developing countries this means that a situation of 'dependency' is maintained as their economies have to import machines and industrial inputs and consequently have to stimulate exports (especially of primary goods) to generate the necessary foreign exchange. Developing countries do not have a well organized sector of capital goods (machine-producing industries). Thus, they simply have not had the opportunity of making capital-saving innovations because they have not had the capital goods industry necessary for them. Under these circumstances, import of capital goods from abroad, has meant that they have not developed the technological base of skills, knowledge, facilities and organization upon which further technical progress so largely depends.

It becomes necessary therefore for developing countries to master locally the flow of needed knowledge and equipment. These countries no longer have the financial means to continue massive importations. In addition, there is a growing awareness that repeated imports of knowledge and equipment do not provide an adequate response to local conditions in terms of demography or of available natural resources.

A key issue at stake is therefore the development of the Research and its application, known as 'Research and Development' (R and D) in the developing countries in order to redress a very unbalanced situation as may be seen from *Table 4*

Table 4

World-wide distribution of financial and human resources for scientific and technical research, 1978

	EXPENDITURES			PERSONNEL — Researchers	
	Total expenditures R & D (in million US$)	Percentage of world total	Expenditures per active person (in US$)	Total (in thousands)	Percentages of world total
World Total	96 418	100.0	66.4	2 279	100.0
Developing countries	2 770	2.9	2.9	288	12.6
Africa (excluding South Africa)	298	0.31	2.8	28	1.2
Central and South America	902	0.94	9.0	46	2.0
Asia (excluding Japan)	1 571	1.63	2.1	214	9.4
Developed countries	93 648 (1)	97.1	182.1	1 990	87.4
Eastern Europe (including USSR)	29 509	30.0	100.0	730	32.0
Western Europe (including Israel and Turkey)	21 418	22.2	135.1	387	17.0
North America	33 716	35.0	331.1	548	24.1
Others (including Japan and Australia)	9 005	9.3	129.8	325	14.3

Source: World Research and Development Survey, 1978.

(1) For 1979, the USA's share of the corresponding amount (119,422) was 47%. These expenditures were carried out by Government (74%), Private Firms (23%) and Universities and Colleges (3%). (Source: "OECD Science and Technology Indicators", OECD, Paris, 1984).

In conclusion, it may be said that science and technology are vital components of economic activity and of society; these in turn create the conditions in which science and the technology can either flourish or wither.

It is important for governments to consider policies for:

1. The promotion of science and the pursuit of knowledge for its own sake. This includes support for the acquisition of fresh knowledge and of new scientific skills, for the education and training of young people and the retraining of older people in new skills, for the dissemination of scientific knowledge to the scientific community and the education of the general public in science. A healthy climate for basic research in all sciences is an essential element, as it is not possible to predict from which part of the spectrum of today's basic research tomorrow's technological wonders will emerge.

2. The application of science and the development of technology which involves the generation of an economic and social climate which encourages the growth of new technologies and the regeneration of old industries through the application of new techniques. It is important to recognize that assistance may be necessary to allow major change to take place smoothly and with due regard to the human problems caused by change.

3. The integration of science and technology into economic and social policies which is essential if science and technology are to develop in a context which is acceptable to society and if science and technology are to be allowed to make their unique contribution to the solution of economic, social and cultural problems.

Lessons from the Chinese experience

> "China has made tremendous strides in industry since 1949. With one of the highest sustained industrial growth rates in the world (8.5% per year in 1957-1982) a full range of production has been built up in nearly every industrial sector. This has been accomplished despite prolonged international isolation, by mastering available technology, improving it and modifying it to suit local conditions. As a result, however and despite some notable technological successes, industrial technology in China has generally lagged behind that of industrialized and newly industrialized countries. One Chinese study estimates that only 20% of China's present industrial technology is of 1960s and 1970s vintage, another 20-25% is backward but can still serve present needs, and the remaining 55-60% should be replaced."[1]

A good measure of the introduction of technology in industrial growth is the concomitant growth of total factor productivity (output growing faster than the total of all inputs). In China, while this seems to have increased in 1952-57 it stagnated or declined in 1957-1982.

Yet, in many cases new technology is neither necessary nor sufficient to improve productivity and product quality. Often the key issue, before the introduction of new technology is better *management* and *organization* of available and installed facilities. Another factor which is required is *consolidation of production*

[1] 'China, Long-Term Development Issues and Options', A World Bank Country Economic Report, Washington, 1985, p. 110. Most material in this section has been culled from this Report.

New technology improves economic results only when carefully *selected* and appropriately *applied* over a long period. Technology cannot simply be transferred since it cannot be thoroughly codified in blueprints or embodied in capital equipment.

Two key lessons seem to emerge for China: (1) the cumulative effect of successful small innovations on cost and quality is larger than that of completely new products or processes and, (2) a large gap exists in every industry and country between the newest technique and the average technique in use. Since it is the average that determines the economy's overall performance, narrowing the technology gap between the leaders and the poorest producers is vital to cost reduction and product improvement.

In China, central government agencies and ministries, with their research institutes and superior resources, have traditionally been considered the best agents for determining what innovations are needed.

Central agencies must play an important role in informing bureaux, corporations, and enterprises about technological developments abroad and in the most advanced enterprises. They should also monitor costs and the physical productivity of key processes thus providing enterprises with feedback on their individual performance in comparison to best (domestic and international) practice.

> "There are severe limitations, however, to the top-down, 'technology-push' approach to innovation. International experience indicates that bottom-up, 'need-pull' innovation is generally much more successful."

A study of major U.S. innovations by source during 1953-73 showed that 80 per cent of new ideas came from within the enterprises that produced the innovation, three-quarters of them from the producing division or department itself while less than 5 per cent came from universities and government laboratories. A similar European study showed that over 70 per cent of the main ideas for innovation came from within the innovating company and that by far the highest proportion of successful ideas came from commercial rather than technical staff. Market feedback is thus the most important source of ideas for innovation.

> "The traditional organization of R and D in China put too much emphasis on technology-push rather than responding to the demands of users for innovation. Only 10-30 per cent of research results are utilized in production. Moreover, research results passed to production units are often incomplete and prototypes require additional development work that the production unit cannot handle. In addition, a high degree of administrative compartmentalization in China may explain why potentially beneficial innovations are often not easily integrated into production if they require the co-operation of other ministries to develop new materials, components, or ancillary machinery."[2]

Overcoming such processes is difficult given the size of the country and the multiplicity of Research, Development and Production units. Yet, from the experience of other countries it would seem that these are pre-requisites to the development of new technology. China faces therefore, decisive strategic choices.

[2] Op.cit., p. 117.

On the assumption that a country wishing to modernize its industry and enhance its potential for the export of finished products will have overcome the 'technology-push' process, it must:

- do better with what it has (produce more and better);
- invent original solutions to match its specific conditions (innovate creatively);
- transform these inventions into viable, marketable and profitable new production units (invest profitably).

The normal sequence of developing technological capability is first to develop (1) *production* capability, then (2) *investment* capability, then (3) *innovation* capability.

Looking at these three dimensions we note that:

1. *Production* capability is needed to ive *operate* productive facilities. This calls for *technical efficiency* and the ability to *adapt* operations to changing market circumstances. This in turn implies personnel with a thorough *knowledge* of production operations, an awareness of the measures to take in order to make the operations *more efficient* (better use of equipment, of time, of workers). This requires an ability to *adapt* through new uses and combinations of existing means in order to achieve the desired results.

2. *Investment* capability is needed to *establish* ive new productive facilities and *expand* existing ones. It is reflected in an ability to identify components and calculate project costs and *tailor* project designs to suit the circumstances of the investment. This calls for organizational and financial analytical skills founded in some degree in creativity. It implies management capabilities often rooted in production experience or at least full knowledge of its processes and operations.

3. *Innovation* capability is needed to *create* or new technology *introduce* existing technologies in a new environment. It is reflected in the ability to introduce processes or services that are less costly or to *develop new products* or services that better meet specific needs. These call for truly creative and imaginative skills.

A word of warning may be useful. These capabilities *do not* necessarily correspond to levels of occupation. They characterize the needs for the development of the industrial sector. Thus a research engineer (at the top of the occupational distribution pattern for this sector) can be said—generally—to possess an innovative capability but this does not necessarily make him capable of creating new technology. If he is an innovator, however, he need not have production or investment capabilities. Conversely, a production engineer may develop an innovation because of his special capability. Likewise, a manager of a new plant is likely to be an engineer with good financial and business talent. He may or may not have the capacity to design new projects. Finally a 'line' production engineer may possess production capability but not necessarily so. He may limit his talents to overseeing the proper functioning of existing facilities without being able to modify or adapt them.

To establish a more general basis for understanding the relationship between Industrial and Technological Development and Research many are the questions which open up the field for data collection or new investigations. Among them, the following seem to emerge:

1. **R and D Spendings and Industrial Growth**

A. What have been spending levels for R and D in the last three decades?

B. What is the origin of funding for research (Central Government, Provinces, Municipalities, Industries and Universities)?

C. Can spending levels for R and D be related to economic growth?

D. Can R and D spending for industry be isolated over the same period?

E. Can the latter (Question D) be related to industrial growth?

2. **Industrial Policy**

A. Should China import foreign technology to upgrade production capability for final consumer products, or give attention first to upgrading technology in producer goods industries?

B. For which industries should technology be imported and for which could existing technology be upgraded through domestic R and D?

C. And in which product lines should China, for the time being, rely entirely on imports?

3. **Industry Technology and Research are still requirements**

What training methods, contents and structures are most likely to respond to needs as defined above concerning capabilities in:

(a) Production?

(b) Investment?

(c) Innovation?

Lecture 2

Industrial development technology and the structure of qualified manpower

by Hans Reiff

Objective of the presentation

First, we are aiming to show the trainees, who are responsible for the planning and administration of institutes of higher learning of different types and categories, how the session on 'Industrial development, technology and the structure of qualified manpower' is situated in relation to the other lecture sessions of the workshop. We do this through the presentation of Figure 1 which invites the following comments:

- The sequence of the lecture sessions proceeds from the right to the left side of the chart, i.e. from Economic Growth via Industrial Development and Manpower/Technology to the process of Developments in Higher Education as determined by considerations of manpower (quantity), occupational skills (quality), technology/research (relevance) and social demand (projections).

- The present lecture session focusses on mainly four dimensions of the above process: (a) Productivity (value added) and Employment; (b) Small-scale Firms and Technology; (c) Organization of Work (as related to obsolescence in industry).

Secondly, it will be explained that in the area under discussion, no models, instruments or tools are available which have universal validity and that therefore the focus will be on a comparison of the situation of China with trends and experiences in a number of developed and developing countries.

Thirdly, given the fact that the trainees daily responsibilities are only indirectly related to the issues underlying industrial development, the focus will be on the relation between skills—technology and industrial development.

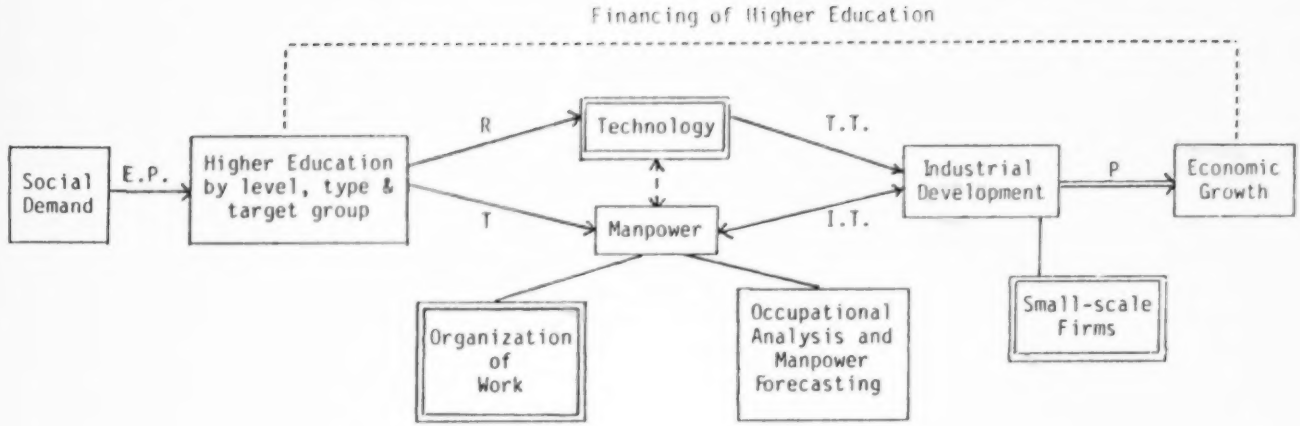
Finally, special emphasis will be given to the problems and potentials of small-scale enterprises; in China almost 60% of firms are small in size (5-33 employees). (See Table 5).

Structure of production and employment

The situation in China is compared with that in other developed and developing countries in Figure 2.

Assignment

Students are requested to comment on Figure 2, given also the data on average value added per worker by selected sector as presented in Table 6. The relative share of manufacturing, services and agriculture in both employment and production is discussed on the



E.P. = Enrolment Projections

R = Research

T = Training

T.T. = Technology Application & Transfer

A = Adjustment processes between technology and skill development

I.T. = In-service Training (by industry)

P = Productivity (value added)

= Focus of workshop session

Figure 1: Relations between higher education, training, manpower, technology, industrial development and economic growth (a simplified presentation)

Table 5

Size distribution of Industrial Enterprises in selected countries(a)

Size of enterprise	China 1982	United Kingdom 1979	United States 1977	South Korea 1981	Japan 1972	India 1976-77	Yugoslavia 1981	Hungary 1981
5-33 employees	59.2	65.2	56.4	70.6	80.2	51.7	6.6	2.2
33-75 employees	19.5	15.7	20.3	14.4	10.7	35.3	15.6	4.8
75-189 employees	12.2	10.8	12.4	9.2	6.1	7.6	32.1	16.7
189-243 employees	8.5	1.4	3.8	1.5	0.8	0.8	12.0	9.2
More than 243 employees	0.6	6.9	7.1	4.3	2.2	4.4	33.5	65.1

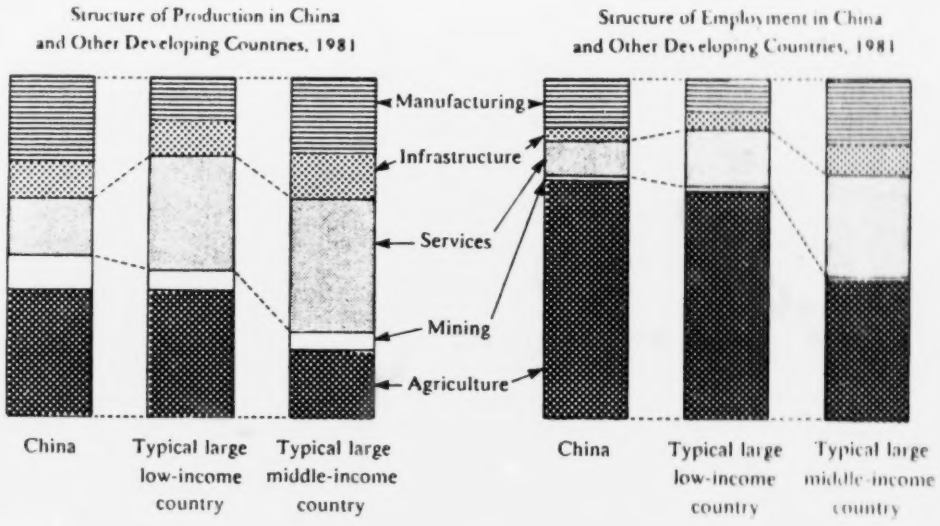
Note: Data are percentages of the number of enterprises with five or more employees in the country.

Source: World Bank, *China: Long-term development issues and prospects*, Baltimore and London, The Johns Hopkins University Press, 1985.

basis of the assumption that China will gradually become a large middle-income country. The students are requested to discuss the probability of situations (A) and (B) of Figure 2 being realistic for the future development of China, given the rather large differences in productivity per worker by sector in China (Table 6).

Technologies and structural change in developing countries

Technological change and the choice of technologies are clearly factors that can have a major impact on the structures, level and conditions of employment and the distribution of income in any country. It is clear that in many industries, especially the so-called 'low technology' industries, the choice of viable technologies is much wider than was once thought and that there is plenty of scope for developing countries to apply or develop more labour-intensive and capital-saving technologies, including the adaptation of traditional and indigenous technologies, in an efficient manner. Developing countries are therefore identifying, developing and applying technologies that are most suitable to national and local needs and conditions. A country's level of development and market pattern clearly influence its choice of technology. At a given level of development, the choice of technology depends on the openness of the economy and the international competitiveness of particular industries. In some circumstances,the use of the most modern technologies available is the only rational path to follow from the point of view of economic efficiency, employment generation and income distribution. Their use may even be essential in order to improve existing traditional technologies. But to meet employment creation and basic-needs objectives in low-income developing countries, a proper mix of alternative technologies, including some that are more labour intensive, becomes extremely important. The nature and pattern of technological change has, in many ways, been a consequence of governments choice of overall development strategies. Where these



Note: Infrastructure includes electricity, transport, and construction; services includes housing.
Source: Annex 5, Tables 3.6, 3.8 and 3.9; World Bank, World Tables, 3d ed. (Washington, D.C., 1984), vol.2.

Figure 2: Structure of production and employment

Table 6

Value Added & Employment in China, 1982

Selected sectors	Value Added (million yuans)	Employment ('000)	Average value added per worker (yuans)
Agriculture	156 600	314 870	497
Manufacturing	132 560	56 160	2 360
Construction	18 200	10 810	1 684
Commerce	28 300	14 570	1 942

Source: Figures on value added and employment taken from World Bank (1985)
China: Long-term Issues and Options
Annex E: China's Economic Structure in International Perspective
Report No. 5206-CHA, pages 55-56 and 64

strategies favoured modern industries and large-scale enterprises, they also encouraged the introduction of sophisticated production techniques. Measures were also taken to provide such large enterprises with capital and foreign exchange and the most modern technologies. Small enterprises using simpler production techniques had no access, or much more limited access, to such facilities.

There is now growing evidence that the alleviation of poverty can itself lead to a greater consumption of goods and services produced by small enterprises using labour-intensive techniques, thereby generating more employment. This requires, as a minimum, that small enterprises using simple production techniques are not disadvantaged in relation to larger and more sophisticated enterprises, and that taxation and credit policies, which have generally favoured the latter, should be reoriented in favour of the former. Large enterprises using modern technology have their role to play, and through linkages with smaller enterprises they can transmit technological innovations to the latter and to the informal sector and small-scale agriculture. Building up a country's technological capacity also requires giving much more emphasis to adapting and upgrading simple traditional technologies (including, for instance, animal-powered farm implements). Moreover, a special effort needs to be made to develop improved tools for women engaged in back-breaking tasks such as weeding and transplanting.

Planners in most developing countries have so far tended to ignore or to underestimate the potential contribution of small workshops to economic and technological development. The production, repair and maintenance of inexpensive but well-designed and innovative farm equipment can improve agricultural productivity; the manufacture, repair and maintenance of spare parts by small enterprises, properly supported and with adequate credit sources, can help to develop indigenous technological capacity. Planners can no longer overlook the inventiveness and innovation of local craftsmen. The building up of indigenous technological capacity also depends on the quality of human resources. Countries with the greatest success, both in coping with more sophisticated, imported technologies and in adapting and upgrading indigenous technologies, are those where the mass of the population is educated. It is also worth repeating that many countries should aim to produce more scientists and engineers than they do. The development of managerial skills is equally important.

Assignment

In connection with the above, students are requested to comment on statistics provided in Table 7, which compares China with three other developing countries in terms of tertiary education enrolment ratios:

Table 7

Enrolment Ratio for Tertiary Education in China and selected countries

	Male %	Female %
China (1982)	1.0	0.3
India (1971)	1.6	0.4
South Korea (1970)	6.2	1.6
Pakistan (1973)	1.9	0.5

Source: World Bank (1985) (a), op.cit., page 179

Another topic that requires examination is the impact of new technologies (e.g. microelectronics, biotechnology and new energy technologies) on employment and development in developing countries. It is not at all clear what this impact will be. Some negative experiences suggest that the widespread introduction of new technologies have eroded the comparative advantage of developing countries. New technologies have changed the structure of production, and many goods in the production of which developing countries had acquired an advantage over the more industrialized countries are, with these new technologies, more profitably produced in developed countries. The mastery and exploitation of new technologies require more sophisticated and difficult skills, and in this way the technological dependence of the developing on the developed countries increased. The widespread introduction of new technologies has therefore militated against building an indigenous technology capacity in the Third World and at the same time has destroyed employment.

More positive experiences show that new technologies offer new opportunities to developing countries. New and traditional technologies have, in many instances, been successfully blended, raising the productivity of traditional technologies without any loss of employment. Also, new technologies have introduced greater flexibility and decentralization of production, and some developing countries have been able to adapt their production structures to these changes more easily than the more industrialized countries. More efficient rural industrialization has thus been stimulated. Moreover, developing countries have sometimes been able to master these new technologies successfully. Many of them have the basic skills in engineering and electronics with which they have developed software and hardware for a number of simple applications. They can also have a comparative advantage in the repair, maintenance and manufacture of parts, thus gaining the capacity to understand new technologies and to seize opportunities for combining them with traditional, indigenous technologies. But to do this, an urgent expansion of the capacity of the educational system is needed, in order to produce people with the right skills, and in the required numbers.

Small business and job creation

Small business and its potential contribution to economic development and employment creation has recently become a topic of some concern in both capitalist and socialist economies. In the West it has been argued that small and medium-sized enterprises have potential advantages over larger ones in areas including (i) technical innovation, particularly in new product development in certain sectors; (ii) human relations within the enterprise; (iii) employment generation; (iv) flexibility and the ability to adjust to changing market conditions more rapidly than larger, more bureaucratic organizations; and (v) managerial dynamism and entrepreneurship. As an example, the rapid economic growth of Japan has been related to the size of the small business sector and the subcontracting relationships between large firms and smaller ones. Analyses of job creation in the USA have also stressed the contribution of small businesses to the growth of employment since the Second World War. Further, there is evidence that while there is a continuing trend towards concentration of ownership in advanced capitalist economies, the scale of production (measured in terms of employment per plant) has been decreasing.

In developing countries, the potential role of the 'informal' sector of individual and small-scale enterprises is also being stressed. The relative abundance of labour relative to capital has been seen as a rationale for developing small businesses as both a means of job creation and a way of increasing production of consumer and simple producer goods. Other approaches, such as that of 'appropriate technology', have often advocated small-

scale enterprises as beneficial to Third World development on social as well as economic grounds.

While the evidence for the contribution of small businesses to growth innovation and employment is substantial, the role of small business has also been subject to criticism. The exploitative nature of sub-contracting relationships between large and small firms has been argued to be a major factor, with larger units able to reduce their costs as fluctuations in demand can be passed on to smaller sub-contractors. Further, small businesses are argued to provide inferior wages, conditions and other benefits to their workers, who are unlikely to be organized in trade unions, thus undermining the past gains of the working class.

Productivity, growth and labour; international evidence and the specific case of China

Economic growth in China is, overwhelmingly, productivity growth. Since the ratio of the labour force to the total population will change little, growth of average per capita income will be almost entirely determined by growth of average output per worker. And, as in other countries, although part of the increase in average labour productivity will come from movement of labour out of agriculture into other sectors, most of it must come from higher productivity within each sector.

Assignment

In this connection, students are requested to comment on Table 8 below:

Table 8

Net output, labour input and capital input in China 1957-1983

(Index 1957 = 100)

	1957	1965	1978	1983
(1) Net Output	100	218.6	677.2	869.6
(2) Labour Input	100	165.5	406.6	474.9
(3) Capital Input	100	310.8	954.3	1 424.9
(4) Total Factor Productivity*	100	97.8	108.2	101.7

* Assuming 60% labour input and 40% capital input

Source: World Bank (1986) Productivity Growth and Technological Change in Chinese Industry by Gene Tidrick, World Bank Staff Working Papers No. 761, page 4

In particular, students are requested to review the relatively high index (1983) for capital input, given the reality in China that 'old' technology in industry is rarely scrapped and that therefore a high ratio of depreciation (amortization) should be applied to all capital assets.

Assignment

After having reviewed Table 8, students are requested to compare statistics contained in this table with statistics on rates of production growth, GDP growth and growth in factor inputs and factor productivity in selected developed countries as presented in Tables 9 and 10.

Table 9

Rate of growth in total production, total factor input and total factor productivity in selected countries(a)

(rate of growth in percentage)

	Total production	Total factor input	Total factor productivity
Japan (1960 - 73)	10.9	4.5	6.4
USA (1960 - 73)	4.3	1.3	3.0
U.K. (1960 - 73)	3.8	2.1	1.8
South Korea (1960 - 73)	9.7	4.1	5.5
Hong Kong (1960 - 70)	9.1	4.3	4.3

(a)Source: World Bank (1986), op.cit.

Table 10

Rate of Growth in GDP in China, U.K. & Japan(a)

	1965-1973	1973-1983
	%	%
China	7.4	6.0
U.K.	2.8	1.1
Japan	9.8	4.3

(a) Source: World Bank (1986), op.cit.

Increases in productivity may lead to the loss of particular jobs. Indeed, rapid and intensive growth depends on this happening on a large scale, with obsolete or uneconomic activities and products being replaced by new and better ones. Displacement of old jobs by new jobs can take place largely within existing enterprises—in other countries, .

employment tends to grow faster rather than slower in enterprises with above average rates of innovation and productivity growth. But part of it must involve movement of workers from one enterprise to another (raising possible issues of unemployment).

Nor is productivity growth incompatible with the 'labour-intensive' development path that some successful developing countries have followed. High labour intensity implies making the best use of scarce capital, land, materials and skills by using them in conjunction with large amounts of unskilled labour, thereby achieving the highest level of output (and hence average labour productivity) that available resources permit. In countries that have, like China, concentrated scarce resources in capital-intensive enterprises, labour productivity in those enterprises has sometimes been high, but average labour productivity in the economy has been reduced.

China has recently begun to encourage the formation of consulting companies, using experts from research and design institutes, universities and ministries. But much more needs to be done to facilitate the creation of new enterprises and organizations that specialize in production of technology-related goods and services. In other countries, units providing services such as repair and maintenance often spin off from their parent firm to provide services on a contract basis to both the parent and other firms, which helps make firms in most industrial capitalist countries less comprehensive than Chinese firms. Large Japanese firms likewise often help set up trusted employees in business as subcontractors. The specialization that results from spin-offs is one of the main vehicles of productivity growth. Greater reliance on small enterprises for innovation could also contribute more generally to China s technical progress. Studies in other countries have shown that small industrial enterprises are just as innovative as large ones, especially in sectors such as specialized machinery, electrical and other consumer goods, and in small computers and related software. Even in sectors where large-scale production is optimal, such as basic chemicals and metallurgy, small specialized firms have contributed many useful innovations, sometimes in the role of subcontractors to the larger firms.

In China, it is generally assumed that small firms are necessarily technologically backward, while large firms must be the technological leaders. As a result, collective and individual enterprises, which already have strong incentives to innovate, are denied access to the skilled manpower, modern equipment and foreign exchange they need to innovate. State enterprises, which have far less incentive to innovate, have exclusive access to the necessary resources.

Given the smallness of employment in the service sectors in China, especially commerce and miscellaneous business and personal services, there are possible economic advantages in its much faster expansion in the future. Service sector activities, being more labour intensive (combining more workers with a given amount of capital and materials), could create more jobs and hence reduce the overall urban labour surplus. These jobs would, moreover, disproportionately employ the categories of labour that are now in surplus in urban China. In the United Kingdom in 1970, for example, women made up 52 per cent of the labour force in commerce, finance, business and miscellaneous services (as compared with 30 per cent in manufacturing), partly because of the greater scope for part-time employment. The service sectors in other countries also absorb many males who lack the skills, physical strength or tolerance of monotony needed for manual work in modern industry. Expansion of the service sectors could thus permit many people who now contribute little or nothing to output in China s factories to move to more productive work. So could expansion of transport, especially road transport, which is much more labour intensive than rail transport.

Assignment

Students are requested to comment on the viability of the above propositions, especially given the forms of industrial ownership in urban China as presented in Table 11 below:

Table 11

Forms of Industrial Ownership in Urban China(a)

	Formal Ownership	*Administrative Superior Body*
State	Whole people	Specialized municipal bureau (or central ministry)
'Big' Collective	Members of group of enterprises	Municipal Second Bureau of Light Industry (or specialized municipal bureau)
'Small' Collective	Members of individual enterprise	District or neighbourhood management bureau (under local government)

(a) Source: Small Business & Socialism in Urban China, Martin Locket, Development and Change, 1986

Obsolescence in industry

Old and new processes and products co-exist in all countries, since it is rarely economic to scrap and replace recently acquired equipment or recently introduced products the moment new processes and products become available. Thus, although China has deliberately chosen to use old and new technology simultaneously as one aspect of the strategy of 'walking on two legs', it could also be said that the typical economy walks on far more than two legs: it is like a centipede, with the newest products and techniques at the front, the oldest at the back. The creature moves forward steadily, innovating at the head, abandoning old products and processes at the tail. But it always remains quite long: the vintages of equipment in use may span two decades or so, with corresponding variations in enterprise profitability, while outputs of widely varying quality are sold at different prices to different segments of the market.

What is unusual about China is the length of the technological centipede, and indeed its tendency to get longer and longer. As new processes and products are introduced, the head moves forward, but the tail does not move. There is very little scrapping of equipment and abandoning of old products, even when it makes good economic sense to do so. Antique vintages of equipment are not merely used, but continue to be reproduced and embodied in new investment on an enormous scale by China's machine-making industry. Equally remarkable is the co-existence of high- and low- quality products selling at the same price, with the result that, for example, inferior bicycles accumulate in inventory while 'famous name' brands continue to be rationed.

There are various reasons for this unusual pattern. Some of them are connected with aspects of China s system of economic management—few incentives for innovation, little

competition, chronic shortages, irrational prices. There is also a widespread, deep-rooted aversion to the 'waste' involved in scrapping equipment that still functions, or any product that might still serve some purpose. This is coupled with intense reluctance to displace workers, largely because of fear that they would become unemployed. These apprehensions have some foundation, but are in important respects misconceived and exaggerated; they will need to be dispelled if China is to make rapid technological progress. The Government, recognizing the outmoded state of much of China's industry, is at present stressing technical transformation of existing enterprises rather than wholly new construction. In general, however, the closure of old enterprises actively stimulates the expansion of technologically more advanced enterprises, creating new jobs to absorb the displaced workers. This is because the continued existence of backward enterprises—as in China—acts as a drag on progressive enterprises, by depriving them of materials, skilled labour, capital and markets that they could put to more productive use.

The possible adverse effects of scrapping on employment should also be put in perspective. Much of the replacement process can occur within existing enterprises: in Japan, for example, lifetime employment in large firms has proved compatible with high rates of product and process innovation, and much the same has been true in other countries.

Over time, and looking at the economy in aggregate, both economic logic and the experience of other countries suggest that high rates of scrapping and replacement cause faster, rather than slower, growth of modern industrial employment. This may require many workers to change jobs more frequently, sometimes with transitory periods of unemployment; it may also, more seriously, cause certain workers and localities to experience employment over longer periods of time. There are policies and institutions that could alleviate the economic hardship of displaced workers and assist in their retraining and re-employment.

Assignment

Students are requested to comment on the apparent contradiction between the foregoing arguments about the advantages of small-scale firms and the statistics on unit costs of products by size of enterprise as presented in Table 12 below:

Labour and employment

China's system of labour allocation allows individual employers and employees uniquely little freedom of choice. Until recently, all young people were administratively assigned to particular jobs—college graduates by the central government, secondary school graduates by local labour bureaux—with little attention to their preferences or the preferences of employers. The assignment was typically for life: with few exceptions (generally dictated from above rather than a result of individual or employer preferences), workers could not move from one enterprise to another. Enterprises, moreover, were not permitted to discharge workers, even if they had more employees than they needed, and even if particular employees were habitually absent, lazy or negligent.

In the last few years, there have been some changes. The system of unified assignment has been dropped for youths with limited training, and enterprises may now examine prospective employees assigned to them by labour bureaux. Some jobs are now advertised. It was recently announced that the best graduates of two universities may choose their own employers. From mid-1984, an experimental 'job invitation' scheme has allowed a

Table 12

Production Costs of Selected Products in China(a)

(A) *Production costs of pig iron*

Big Enterprise	138 Yuans per ton
Medium Enterprise	192 Yuans per ton
Small Enterprise	304 Yuans per ton

(B) *Production costs for bicycles*

Big Enterprise	70 Yuans per unit Small
Enterprise	200 Yuans per unit

(a) Source: World Bank (1985) (a) 'China : Long-term Issues and Options,' The Main Report Report No. 5206-CHA, pages 101-103

few organizations to offer jobs which they may later terminate to particular individuals, the individual also having the right to refuse the offer or subsequently to withdraw. Another experiment, covering 300,000 workers in early 1984, involves 'job contracts' between enterprises and new employees, often for three to five years, specifying mutual obligations in regard to wages, performance standards, contract renewal and firing. Enterprises are now in principle allowed to dismiss unsatisfactory employees. Finally, there has been rapid growth of the commune and brigade and individual enterprise sectors, where employment decisions are subject to little administrative regulation.

Most governments in Western capitalist countries assign graduates . only for compelling reasons. For example, a few with training in much-needed skills might be asked to work in remote areas for a fixed period. Centrally planned countries assign some graduates to their first job: for example, Hungary assigns doctors and teachers. Hungary, Romania and the Soviet Union all allow some choice of assignment, at least to the best students, which provides an incentive for good performance at school. Furthermore, these assignments usually last only three years. Many workers then choose another job (perhaps because they were poorly assigned, or perhaps because the assignment process is used to fill inherently unattractive positions). In the Soviet Union, the first year of assignment became a probationary period. The enforcement of assignments, which was once very strict, is now rather lax.

Assignment

Students are requested to comment on the above section on labour and employment in the light of statistics on workforce, employment and wages in different organizational types of industry in China as presented in Table 13 below:

Table 13

Employment and Industrial Sectors in China, 1983

	State	Urban Collective	Urban Individual	Rural Commune/ Township	Total
Total workforce (million)	87.71 (19%)	27.44 (6%)	2.31 (0.5%)	342.58 (74%)	460.04
of which: Industrial workforce (million	35.52 (59%)	15.74 (26%)	0.24 (0.4%)	8.73 (14%)	60.23
No. of Industrial Enterprises(a)	87.100 (22%)	118.500 (30%)	na(c)	186.100 (47%)	392.500
Gross industrial output value(Yuan billion)(b)	475 (77%)	94 (15%)	1 (0.1%)	41 (7%)	616
Fixed assets (Yuan billion)(d)	477 (89%)	37 (7%)	na	24 (4%)	538
Profits (Yuan billion)	64 (84%)	8 (10%)	na	5 (6%)	77
Taxes paid (Yuan billion)	39 (85%)	4 (10%)	na	2	46
Workforce in heavy industry (million)	24.12 (80%)	6.05 (20%)	na	na	na
Workforce in light industry (million)	11.40 (54%)	9.68 (46%)	na	na	na
Employment growth rate (annual)					
(i) 1966-78	5.6%	3.9%	na	na	na
(ii) 1978-83	3.4%	6.2%	na	na	na
Average earnings (Yuan)	865	698 (81%)	na	na	na
No. of women workers (million)	28.15 (32%)	13.84 (50%)	na	na	na
of which: Industrial women workers (million)	11.79 (33%)	8.89 (56%)	na	na	na

Notes: (a) 'Industry' excludes construction and energy sectors and so is similar to western manufacturing categories.

(b) Industrial output gross value is at 1980 fixed prices.

(c) 'na' indicates not available or not applicable.

(d) Figures for fixed assets, profits and taxes are for independent accounting collective enterprises only.

Source: Small business and socialism in urban China, Martin Locket, Development and Change, 1986.

A comparison

There are substantial structural similarities between the role of small business in urban China and that in capitalist economies. It was seen that, in general, small enterprises were subordinate to large ones, most clearly when they were in a position of dependent subcontracting. Small businesses also provided greater flexibility in the economy as a whole. Small business appears to have been a significant mechanism of employment generation. This occurred through (i) expansion in the number of small businesses through the creation of new enterprises and (ii) the growth of small businesses, often into large-scale enterprises. Another structural similarity is in the stratification of the labour force, with workers in small business having lower pay, less job security and fewer welfare provisions than those in large enterprises.

There are also some major structural differences between small business in urban China and that in capitalist economies. One major difference is in the structure of ownership.[3] In urban China ownership has taken non-capitalist forms, primarily those of cooperative and collective ownership, though to varying degrees supplemented by private individual ownership of very small businesses. China today has far more organizations which are formally producer cooperatives than any other country. This has been associated with a strong state role in planning and overall control of the economy, for example over prices and wages. As a result of these differences, in the mid-1970s China did not have a recognizable 'informal' sector like that in most Third World countries, as nearly all urban workers would be in formal jobs with regular (if low) wages. Since the late 1970s, the growth of individual employment has changed this picture somewhat. While there are these positive features of small business in urban China, it is also clear that it has not played a significant role in technical innovation, as urban collectives have been deprived of some of the key resources needed, in particular skilled manpower and access to materials, often in short supply. Thus, while there are many small enterprises in China, there are few which provide specialized skilled services or 'high technology' products.

There is in theory a fairly clear legal framework for urban collectives which makes them similar to producer collectives. In practice, however, urban collectives have been run as local state or neighbourhood enterprises (collectives) rather than as independent accounting democratic cooperatives. While urban collectives have been deprived of necessary resources and had reduced incentives, the existence of the planning system and features such as price control and lack of competition in many fields have meant that urban collectives have been able to prosper more than would have been likely in a competitive market-place.

Since 1978 and particularly since 1984, economic reforms have been implemented in urban areas. These have introduced competition into the urban economy as well as reducing the differences between state and collective ownership in a number of areas like the tax system for profits, internal democracy and independent accounting. At the same time, restrictions on the collective sector (such as those on recruitment and pay scales) have been relaxed. In the longer term, these reforms are likely to change the role of small enterprises in the urban collective sector. In particular, inequalities between them are likely to rise—with those in the most successful having wages and benefits at least as high as in the state sector, but with the less successful in a worsening relative position. In this case, one could foresee a declining importance of the institutional divisions between urban collectives and the state sector, while divisions associated with economic forces increase.

[3] See Table 11

Industrial Growth / Institutions of Higher Education		Comprehensive Universities	Specialized Institutions		Adult Education at Higher Education Levels	
			Technical/ Specialized Universities	Post-Secondary Technical Colleges	Post-University Training	Workers Colleges
PRODUCTION	Large (modern technology)	e.g. MS, etc.			MS	PS
	Small (local needs)					
Technological Development						
Scientific Research						

PS = Productivity Skills CS = Creativity Skills MS = Management Skills

Figure 3: The role of higher education and training in skill development for industrial growth

Assignment

As a final assignment, students are requested to complete, or, alternatively, modify and complete, Figure 3, which attempts to relate three dimensions of higher education and industrial development, i.e. (i) various types/levels of institutions of higher learning; (ii) various skills required by qualified manpower; (iii) different characteristics of the industrial development process. Students are also requested to reflect on ways by which the question of specific occupations and different higher education diplomas and degrees can be introduced in order to enrich the comprehensiveness of the Figure.

Lecture 3

Training qualified manpower: the joint role of higher education and enterprises

by Hans Reiff

Objective of the presentation

In the area under discussion, there are no tested methods and techniques which would have universal validity. Therefore, learning is more likely to take place by sharing information which emerges from ongoing innovative experiences in a number of countries. This session, therefore, provides a general introduction to international trends and experiences in the joint role of higher education and enterprises in the training of qualified manpower, illustrated with selected examples from country experiences. The role of science and technology will be particularly stressed as, in most instances, training is directly related to scientific research and technological development. While in the areas of technical and vocational education and training there may be separate roles for educational institutions and industrial enterprises, in the areas of higher education and post-graduate training, international experiences reveal that there is mainly a joint role between these two types of institutions. Future developments in China in this area should therefore be guided by lessons regarding the ways and means through which these joint and complementary roles of the industrial and educational sectors have been harmonized and rationalized.

The lecture sessions (divided into two parts followed by group work) will proceed in the following sequence:

First session

(a) Recent trends in industrial training, retraining and updating programmes (illustrated with country specific examples)

(b) Prerequisites for success

(c) Assignment of groups and reporting to plenary

Second session

(a) Universities and 'new' industries: cooperation in training and research

(b) Universities and 'old' industries: cooperation in training

(c) The 'case' of China

(d) Assignment of groups and reporting to plenary

Recent trends and experiences in industrial training, retraining and updating programmes

Most successful experiences in the joint role of industry and universities in training qualified manpower are characterized by a complexity of traditional and new forms that reflect both the various types and states of industries and the various capacities, values and interests of higher education institutions. These aspects vary greatly between countries and, as a consequence, not only is it hard to draw lessons from the experience of one country, but also the transfer of that experience to another context is extremely limited. In most countries, university/industry relations in the area of training qualified manpower have entered a new phase in terms of goals as well as magnitude. The need to explore new forms of communication and collaboration arises partly from the pressure of competition on the side of industry, partly from financial problems on the side of the university, and on the whole from the fundamental scientific and technological requirements of progress in many areas of research,

'Internal' industrial retraining is an internationally common feature. Companies, especially the large ones, who are highly dependent upon keeping in the forefront of Science and Technology (S & T) developments (both at basic and applied level) usually undertake considerable in-house retraining through their own training departments, internal workshops and seminars and intelligence scanning. Similarly, the regular inflow of new graduates from higher education has its own vitalizing effect, though there can be problems of a timelag nature before such new entrants are in a powerful enough position to make their mark. At a time of relatively incremental S & T change then, it is usually possible for the larger companies to maintain their own momentum and capability updating. At times of more radical change, however,—as is the case now with respect to a range of S & T developments, but especially with respect to micro electronics—added difficulties ensue. This can be further complicated if, as in the case of China, the flow of candidates from higher education is insufficient to meet industrial needs in certain key science, energy and electronic areas. Indeed, university staff itself may have difficulty in keeping up with the rapid change in the development of knowledge. Many developed countries face, simultaneously, problems brought about by the rapid and discontinuous nature of technical change, the contractive nature of the education system due to cutbacks, the recognition that S & T output in academic needs to be expanded and reoriented (but; is compromised by the 'contraction'), the need for industrial-academic co-ordinated approaches and the need for new multidisciplinary planning routes.

Several paradoxes or new problems abound at a time of radical change: *industry* may not be able to 'retrain' itself using its own internal resources. Equally, *universities*, under the twin pressure of the rapid change of knowledge, will have to 'retrain themselves' while they are compromised by the resource cuts they are experiencing. Also the influence of new graduates in companies is insufficiently rapid and by the time they make their mark, their knowledge is partially obsolescent! Added to this, normal academic boundaries are often insufficient to cope with the training of new S & T aspects of individual needs. Engineering, Computing Science, Electronics, Production, Manufacturing Procedures and Design are taking on very new concepts and academic may have only partial experience in designing adequate training programmes in these areas. Such new areas as Computer Integrated Engineering (CIE), Advanced Manufacturing Technologies, Advanced Computing Systems, all throw tremendous challenges on companies as well as on universities when viewed against traditional manufacturing, production, design, research and training procedures.

As an example of problems in the areas of research and training as experienced in the United Kingdom, the following selected quotes from an influential national report in this area[4]

> "Applied scientists and technologists working in R & D in electronics systems for one major IT firm considered that most of their specialist skills had been acquired less than 5 years before. Research by IBM in America has lead them to conclude that in computer science knowledge becomes obsolescent 2.7 years after graduation unless it is updated. The MSC said that 50-75% of the workforce would require some retraining within the next 5 years if they were to match the demands of new technology.
>
> The greatest short-term demand for specialist manpower is in information technology. If one is talking about numbers, numbers required in this area overshadow all other problems which might appear in other areas of expertise. The manufacturing and services industries would need to recruit 50% more graduates in 1984 than in 1983, and with a projected growth rate of 20% per annum in the industry, the pool of scientists and technologists would need to grow by about 8% per annum. The shortfall in IT which is 1,500 graduates now, will be rising to 5,000 by 1988. The combined demand for technologists and technicians would grow at 5-8% over the next 5 years, and if current levels of training continue, there would be a shortfall of 7-10,000 technologists by 1988, mostly in IT field.
>
> Shortages occur at all skill levels but are probably worst in software engineering, systems integration and advanced production technology. Too often contracts are being lost, and employment opportunities for the less skilled are being lost with them because of the lack of a few 'key' engineers. Competition for these people is increasing from users and from overseas companies establishing in the UK, neither of which, for the most part, have shared the cost of training and development. The shortage is also felt in the training sector, which has lost many of its best people to industry, and hence there are further doubts about the quantity and quality of the next generation of graduates—whatever initiatives are taken.
>
> The articulation of industrial needs depends on industry which has a responsibility to communicate its needs,and to exploit the great intellectual resources of the universities. No organization outside industry can tell industry what it needs. However, industry does not have a good reputation for anticipating long-term requirements because of its preoccupation with short-term problems.
>
> Though occupational training is essentially the responsibility of employers, such responsibility has not been clearly allocated in the system of basic training. On the one hand, the system itself is confused and patchy, with the proliferation of statutory and non-statutory training agencies following the dissolution of many of the Industrial Training Boards. On the other, the character of occupational skills has been changing as they increasingly cut across individual industrial sectors, and across traditional levels of skills. Training should be broad and teach transferable skills; over-

[4] Source: H.M.S.O. (1984): Education and Training for New Technologies; Report of the Select Committee on Science and Technology Session.

specific training by employers would not provide the flexibility of a mobile workforce. The requirements of training in new and transferable skills has made out the case for some financial help to employers from Government".

Two examples (both from the United Kingdom) can illustrate how programmes have attempted to cope with these problems. The Integrated Graduate Development Programme (IGD) is at a national level and is located at six university or polytechnic centres around the UK. The programme impera was initiated in 1980, when it was recognized that there is an imperative need to update industrial managers and researchers in best practice techniques. The courses are jointly designed and managed by industrialists as well as academics but are run on a repeated modular/residential basis in academic. The strength of the courses (in total they amount to a one-year Master of Science type course, but the emphasis is upon empirical practicality rather than academic accreditation *per se*) is their flexibility, up-to-dateness, relevances to industrial needs, modular repeatability and hence the important practical consideration that individuals occupying challenging and often highly senior and pressured employment can attend on a flexible schedule. The students may be engineers, design managers with several years' experience in industry, graduate researchers, etc. The six individual programmes are related to such areas or sections as: transport and aerospace, computing, process-plant industry, construction industry, etc. Several major companies interface into a relevant sectoral course. A particular strength of these courses is the local *joint* management committee (company academic, industry and research council representatives) which provides an important co-ordinatory and supervisory role in order to ensure 'relevance' and up-to-date S & T input. The second strength, however, is the multi-disciplinary and 'systems approach' which relate S & T developments to *total industrial practice.* An important derivative value of the course from a communication and attitudinal standpoint is the bridge-building between academic and industry itself. Several hundred undergraduates have now been through such courses. The financing was initially from the UK Department of Education and Science, but is intended to be partly or fully financed by Industry at a later stage. One of the prime motives behind the course was that to reduce the 'time-lag' problem whereby new graduates take too long to make their mark. At the same time the level of national and company urgency in relation to new S & T development requires immediate updating of individuals who are at the 'cutting or leading edge'.

The second example of 'updating' and 'retraining/familiarization', at a very senior level, is the Austin Rover Course for Directors, presently being run over a period of 18 months or so, held at Warwick University. In one sense, some of the features are similar to the scheme just described (e.g. the repeat-module structure, the joint collaboration of industry and academic). However, the emphasis of the course is considerably wider and strategically important. The course, attended by the majority of Directors and Senior management of the company, aims to address a wide range of issues related to 'High Technology' and what this implies to the company, from the point of view of manufacture, production, design and strategic planning. The course is partly financed by the UK Manpower Services Commission and the general features and approach of the course may form the basis of a wider, more nationally accessible, initiative. Again, like the IGD programme referred to previously, the course offers important organizational and procedural lessons in terms of academic-industrial-S & T co-ordination in the area of training highly qualified manpower.

Pre-requisites for success

Each country has a particular set of institutions of higher education and a particular industrial complex; the patterns of university/industry relations reflect this particularity. It follows from this that there is no single model to describe effective university/industry collaboration in training; much depends on the needs of firms whose interests are to be served as well as on the capacities of the university system to provide them. It is also clear that, given the diversity of training needs which an extensive and differentiated industrial system manifests, the capacity of the university to initiate and to respond adequately will be intimately related both to its own traditions and to the role it sees for itself.

In each country, a detailed analysis of the industrial structures, attitudes and opportunities is needed to clarify conditions to be met by industry in order to facilitate the establishment of a continuing and constructive training relation with universities, in line with the national industrial and manpower strategy followed by the country in question.

In all cases, the collaborative arrangements in training and research which have seemed to be most appreciated by all parties have been based on:

- The existence, within the firm, of a long-term planning effort, an articulated strategy for growth and a detailed manpower plan.
- A management structure in the firm which can flexibly absorb external advice and training programmes.
- A willingness to pursue actively the recruitment of the highest possible level of qualified personnel and to provide for their retraining.
- An understanding of the 'university ethos' regarding exchange of information, diffusion of results, etc. through training programmes.

From the point of view of *governments*, the primary objective of university/industry relations in training and research is generally to contribute to the national economic performance by enhancing—and perhaps accelerating—the process of technological innovation. For *industry*, it usually means access to adequately trained personnel, to scientific and technological information, occasionally to research results. For the *universities*, it is—of course—a potential source of resources (funds as well as equipment), and there seems to be an increasing sense that one of the training functions of universities is to contribute to regional—and thereby national—development. Finally, for the *research scientists*, stronger relation with firms which have been pioneers in certain disciplines is often seen to be a necessity from the point of view of research and post-graduate training.

Many universities do not wait passively for industry to present them with enquiries, demands and opportunities. They seek a new role in research and training, and they also take the initiative, often with the support of public authorities.

- Various efforts, ranging from 'science shops' to 'open days' and seminars for the local business community can be launched and pursued systematically to initiate a dialogue in matters of joint training.
- Adequate administrative and budgetary measures will ensure the required flexibility and enable the universities to enter with industry into as broad and diverse a range of cooperative training agreements as possible.

- Countries should identify regulations which diminish flexibility, at the institutional and individual levels, in responding to industrial requirements in the area of training qualified manpower.

- Industrial liaison services can be established within universities to serve as a sensing service oriented towards the training needs of the industrial world. Such services may require, in order to be effective, administrative and budgetary resources which should be available on a permanent basis.

- Often, the central focus of a particular form of industry/university collaboration has gradually shifted from education to retraining of highly skilled personnel and subsequently to joint research.

- One of the most apparent sources of rigidities in some countries is, in particular, the difficulty for academics and industrialists to move, even for brief periods of time, from one sector to the other. Various career and retraining schemes can facilitate and encourage short-term or medium-term mobility.

Group assignments

The working groups all received the same assignment, and students were requested to judge (as a group) whether a number of conditions for successful cooperation between industry and institutions of higher learning in the field of manpower training were fulfilled and, if so, to what degree (ranking 1 to 5). Groups were encouraged to come to a consensus but in some of them individual scoring took place, eventually leading to an average ranking of the group. Questions were divided into prerequisites for successful cooperation in training within industries and within universities. The questionnaire, which was slightly modified after some initial testing, is presented as Figure 4.

Universities and 'new' industries: co-operation in training and research

Small and medium-sized firms

Many efforts to promote growth of high technology industries have focussed on small and medium-size firms. Universities are expected, at both regional and national levels, to contribute to the implementation of this policy by establishing joint research and training projects with industry.

The mismatch between the general capabilities of universities and the highly specific needs of small firms have limited, and will continue to limit, the possibilities for direct collaboration. Yet, universities have occasionally succeeded in initiating cooperation with small firms through various *mechanisms*:

- The placement of graduate students in an industrial environment, under 'sandwich course' types of programme, has been very useful in this respect and has been the source of many permanent training contacts;

- Students have also been usefully encouraged to undertake, as part of their training, the solution of industrial projects under the supervision of both their professor and the manager of the firm concerned;

	Rank Score 1 = low Score 5 = high
1. *Within industry*	
1.1 The firm has an effective long-term planning strategy including estimates for future needs of qualified manpower as well as an *efficient* monitoring and assessment system	
1.2 The firm has a management structure and a system of *incentives* which encourages external advice in research and training from universities	
1.3 Large and small firms are able to *recruit* the highest possible level of technically trained university and college graduates	
1.4 The firm understands and allows a free exchange of information and diffusion of research results which can be used in the design of training programmes (problem of patents)	
2. *Within Universities/Colleges*	
2.1 Universities/colleges have industrial *liaison* services in research and training and the administrative/budgetary support is adequate	
2.2 Universities/colleges place graduate students in *'sandwich course'* programmes, allowing them to alternate education and work	
2.3 Students are encouraged and have the actual possibility to undertake the solution of industrial projects as part of their training	
2.4 University staff can become *consultants* to industry in research and training with adequate incentive remuneration	
2.5 There are University *'Consortia'* (groupings) which cooperate with Industrial 'Consortia' (Groupings) in the area of joint, broadly-based, training	
2.6 There are adequate mechanisms to establish international linkages among universities in science and technology training	

Figure 4: Questionnaire. Are the following conditions for successful cooperation in training between industry and universities in China fulfilled?

- Opportunities for contacts are mainly realized when academic personnel benefit from statutes which make them available as training consultants to industry and allow them to be remunerated for these services;

- Various forms of industry/university cooperation in the area of training have been stimulated by the creation, often on a regional basis, of 'industrial consortia' which are in a better position than their individual members to express training requirements to the university and interact with it;

- Finally, industry/university cooperation is not always direct and may flow through various intermediary and collective training and research bodies who are encouraged to look to university contributions, especially in the area of short-term retraining of staff.

Selected examples of successful mechanisms

Rennsselaer Polytechnic Institute (USA)

One of our most successful relationships with industry is in computer graphics—in computer-aided design. This relationship is all encompassing, it involves an affiliated programme with many companies; specific research and problem solving arrangements with individual firms; continuing education and training programmes, both broadly-based and specifically tailored for a company's needs; consulting by faculty members and an exchange wherein people from industry serve as adjunct faculty. The programme started following a concern about the loss of all hands on experience in the curriculum such as drafting, surveying and shop courses. The answer was in the then emerging new tool of the engineer—the inter- active computer graphics terminal. A classroom of 36 terminals, driven by two mini-computers, was set up and demonstration programmes for most of the undergraduate engineering courses were developed. Soon 2,700 students, the entire undergraduate engineering enrolment, passed through that classroom every year. Next came graduate education and research. Graduate students are involved in developing the computer programmes for undergraduate teaching demonstrations. Research is conducted in the same laboratory complex that includes the undergraduate classroom, thus assuring linkages between graduate and undergraduate education.

Helsinki University's Lahti Centre and the Fur Industry (Finland)

One current project is concerned with the development of the fur industry. It derived from a perception by staff of the Centre that while Finland is a major producer of fur, much of the product is of low quality and, moreover, very little of the total output is made up into manufactured goods within the country. The project was initiated to help fur farmers improve the quality of their furs, and to extend its processing, thereby increasing added value and creating jobs. The project has four parts:

- A training project, in conjunction with the vocational training centres. This is a three year course directed at training teachers, supervisors and designers for the fur sewing industry;

- A research project, involving various scientific departments of the university, aimed at improving the quality of fur. Some financial support from firms has been received;

- Economic research on world markets, in cooperation with Turku University of Economics;

- A research and development project aimed at transferring technical know-how from the clothing industry into the fur industry. This involves collaboration with the College of Art and Design and is concerned largely with improvement of manufacturing processes and machinery.

The Industrial Research Education Programme (Denmark)

The education is offered to graduates with a university degree provided their qualifications are deemed to be satisfactory. Graduates with some years' practical experience in a research institution or industrial enterprise are preferred. The programme is administered by an industrial research committee set up by the Danish Academy of Technical Sciences. Financing is based upon agreement between the enterprises and the institutions involved, the State generally paying 50 per cent of the costs and industry the other 50 per cent. Normally the education comprises work for two years partly in industrial development departments, partly in research and development institutions: it is combined with supplementary studies and courses of planning, and implementation of industrial development on an advanced level. For a substantial part of the education period, the graduate carries out practical work in connection with real development projects, and this work is based upon the cooperation of at least one research institute together with one or more industrial enterprises. The programme aims at acquainting the graduate with the total process of development and at making him/her understand, and adopt a positive attitude to the problems of industrial development.

The Value-Engineering Workshop at McGill University (Canada)

To date, the workshop has helped about 70 companies to cut costs and improve their competitive position whilst helping students to learn to apply their textbook knowledge to practical problems in industry. For a reasonable fee (which covers the university cost in hiring an outside consultant to run courses and seminars) the companies involved have achieved savings representing millions of dollars. Examples include work for an aviation company on a costly fuel control system for aircraft turbine engines that had resisted change for 25 years. Another project—to improve the cost performance of a scavenger pump for a diesel engine oil system—resulted in the team eliminating this pump completely and improving design of the main oil pump instead.

Large, science-based firms

In this type of collaboration, both universities and industry are usually operating at the forefront of research and play a part in an international network of activity. Relations between these types of firms and universities, then, must depend on the excellence of the latter and on developing an ethos of 'equal partners' in training and research. Links between these firms and university are often to be made with individual scientists of high standing and, in some cases, industry has invested large sums of money in specific university departments to 'formalize' relations between the parties.

One of the salient features of the connections in training and research between this type of industry and universities is their long-term aspect, potential for continuity and variety:

- Continuity can be maintained if the relationship starts on a sound basis from the point of view of the various parties (including university administration, individual scientists, industry officers and scientists, etc.);

- Governments can be involved in many ways, and it may be useful, in consultation with industry, to determine areas where public funds can play a 'seeding function' through the provision of advanced facilities and equipment for training activities;

- The development of international industry/university cooperation is one of the important new trends in this area which raises many issues regarding the harmonization of training programmes and their degree granting functions which have not yet been fully explored.

'Old' industries

'Old' industries may be large or small but this stage of the innovation cycle may be the most difficult within which to foster university/industry relations in the area of training. Frequently, unable to interest government or to attract high quality graduates, these firms seem to be set on a path of inevitable decline. Such firms may need more, not less, investment in R & D and require more, not fewer, highly qualified graduates in their workforce. It is in this area where new approaches are often required with respect to the recruitment of qualified personnel, and where much greater effort is needed, to identify how academic capabilities can be directed to revitalizing these industries and help in the often socially and economically painful process of introducing available new technologies in these industries.

One key problem in this area is related to the difficulty of initiating training linkages between 'old' industries and traditional universities which are often located in the same regions. In many instances, the interest in training will be in applying new technologies to improve the production and competitiveness of industry. On the university side, contributions in the area of training may therefore often originate from engineering rather than science departments.

- In many cases, the inclusion of engineering education and technological research on campus has done much to modify the general outlook of a traditional establishment of higher education.

- Here again, 'sandwich courses' and retraining for highly qualified scientific and technological personnel open the way to new relationships.

- The development of industrial liaison training programmes has often started, from the university side, with efforts to organize increasing informal contacts (through social occasions, seminars, etc.) with industry.

- On the industrial side, management should seriously consider the setting up of university liaison services whose tasks would be to initiate contacts in the field of training and retraining with university groups.

The case of China

China, in 1985, put forward her seventh Five Year Plan (1986-90). The Plan includes an enormous expansion and development of 'Science and Technology (S & T) Higher Education' as the key to her economic development and modernization programme. Amongst the various educational proposals, the following are intended for the next five years:[5]

- 'Producing 2.6 million graduates and 200,000 post-graduates in science, technology and management—an increase of 70% and 400% respectively over figures for the last five years.
- Sending much larger numbers of students to overseas universities.
- Vigorously strengthening higher education's links with industry and taking further steps to ensure that research and study is geared directly to profitable production and the development of new technology growth areas.
- Turning out two million specialized scientific, technological and cultural personnel from the country's colleges, at or above degree level.
- A huge expansion of technical and vocational education in the schools.'

In order to achieve the economic aim of doubling industrial and agricultural output value, the proposal states 'that education's role in producing adequate numbers of appropriately trained specialists in science, technology and management and effectively pursuing appropriate research, was the key to achieving all its objectives, and it was because of shortcomings in the area that China continued to lag behind the developed nations'.

We can see in the above an encapsulation of almost every one of the main elements required for an improved coordination of policies and plans in industry on the one hand, and in higher education on the other hand, namely: the expansion of S & T commitment; increased number of S & T graduates and an improvement in the quality of training; the focussing on the new technical areas; the importance of management skills and the linking of academic and industry more effectively. But China has also recognized two other important requirements; first, in an LDC setting the importance not only to absorb new products, but to 'master and further develop' (as Japan did), and second, the critical importance of maintaining a strong basic research profile.

China is now embarking on an education expansion programme that has, in some ways, plateaued in other nations. She is placing some reliance on overseas training and the purchase of foreign equipment and expertise—and in these two senses is open to the potential problems of relevance and knowledge transfer. But she has a considerable advantage over attempts made by other LDCs in that her economy is large enough to develop its own critical-mass structure and the direction of new technologies is for her to some extent 'mapped out by contemporary research'. She also has the value of hindsight learnt from other LDCs' mistakes. Nevertheless, even for an essentially centrally planned economy, the national requirements for co-ordinating Education and S & T policy remain enormous and will require continuous monitoring and assessment, not only with respect to the internal logic of S & T and Education and Development, but also in terms of effectiveness and utility. It is here that there is a major problem due to the time scale of

[5] Source: G. Parkins, the Times Higher Education Supplement, 8 November 1985

'diffusion and effect'. The educational infrastructure and S & T consequences may well be favourable, but often their positive economic effects do not show up for some considerable time. This can apply to failures . as well as to successes in planning-policies. In a very large centralized economy, this can present enormous problems in terms of phasing in and phasing out programmes, flexibility and experimentation.

An effective training, retraining and updating mechanism which can ensure that the programmes are being staffed by highly trained manpower, especially in the areas of science and technology, will require a very innovative, decentralized system of monitoring and assessment.

Group assignments

Given the above account of international experiences and given your knowledge of the situation in China : (i) make and argue your choice whether Chinese reality (not intentions, plans, regulations) resembles Figure 5, 6 or 7; (ii) if we were to assume that Figure 7 presents the 'best' future alternative, what concrete measures will need to be taken to move from Figures 5 and 6 to Figure 7?

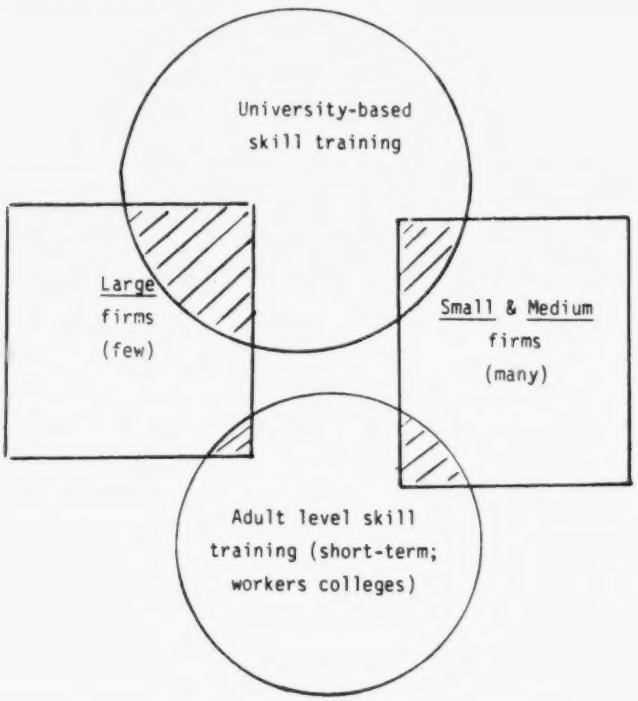


Figure 5: Group assignment. Situation in China: first option

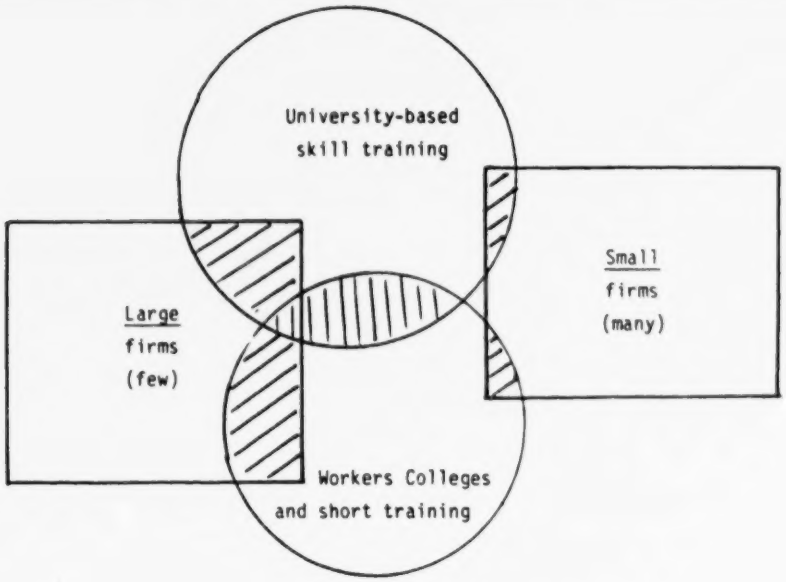


Figure 6: Group assignment. Situation in China: second option

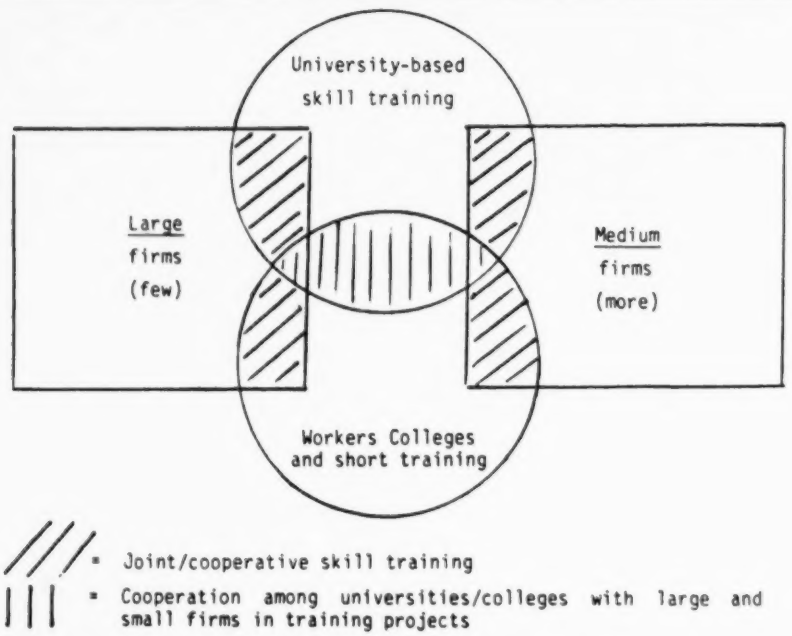


Figure 7: Group assignment. Situation in China: third option

Lecture 4

The structure of the industrial sector

Ta Ngoc Châu

Objective of the analysis

The general objective obviously is to study the trends and more precisely the growth of the industrial sector and its effects on employment and productivity.

The first step in this analysis consist in classifying the activities of the Industrial sector into broad categories or branches of activities the common feature of which is the production of the same family of goods and services.

The justification of such classification is that the type of technology used in the various sectors of economic activity is not the same. As a consequence the productivity and the structure of qualified manpower may vary from one sector of activity to the other.

Classification of economic activities

A well known classification[6] has been developed by the Department of Economic and Social affairs of the United Nations. It is called International Standard Industrial Classification of all economic activities (ISIC). The main purpose of this classification is to facilitate the 'compilation and analysis of internationally comparable data'[7] and thus, to make international comparison of the economic growth of the various country.

Two main sets of criteria have been employed in defining the categories of the ISIC.

The first set of criteria concerns the manner in which activities are combined in, and distributed among, establishments. This is meant to ensure that the units falling into each group will be as similar in the kind of activities in which they engage as is feasible.

The second set of criteria relates to the characteristics of the activities, e.g. the type, technology and inputs of production. These characteristics are strategic in determining the degree of similarity in the structure and experience of the units and certain relationships in an economy. The major aspects of the activities considered were:

- The character of the goods and services produced
- The uses to which the goods and service are disposed of
- The process, technology and organization of production.

[6] United Nations, Department of Economic and Social Affairs, International Standard Industrial Classification of all Economic activities, New York, 1971.

[7] ibid p. 3.

For analytical purposes it is obviously important to group producing units according to degrees of similarity in *cost-structure, the relative magnitudes of the fixed capital and labour employed, and the relative productivity and scale of operations.*[8]

The ISIC uses four level of classification:

- major divisions
- divisions
- major groups
- groups.

The major divisions are:

(a) Agriculture

(b) Mining and quarrying

(c) Manufacturing

(d) Electricity, gas and water

(e) Construction

(f) Trade, hotels and restaurants

(g) Transport, storage and communication

(h) Financing, Insurance and Business services

(i) Community, Social and Personal services

(j) Activities not adequately defined.

More detail about the major divisions and the divisions is given in the Annex.

The economic structure of China

In China, economic data are often presented according to 19 sectors of activity. Table 14 gives the value according to these sectors of activity.

There is of course close relationships between the various sectors. The gross output of a sector can be divided into two parts: intermediate use and final demand. *Intermediate use* refers to the use of the gross output of a sector by other sector either under the form of raw material or semi-finished products. For example, a part of agricultural production is used by the food industry as raw material. *Final demand* relates to household consumption, public consumption, export, i.e. direct use of the final product.

[8] cf. United Nations, *op. cit.*, pp. 10-11.

Table 14

Value added by sector of activity (millions)

Agriculture	156 600
Metallurgy	14 650
Electricity	10 630
Coal	7 260
Petroleum	13 400
Chemicals	18 690
Machinery	37 770
Building materials	9 610
Wood	4 670
Food	18 040
Textiles and clothing	31 260
Paper	6 550
Other manufacturing	5 970
Construction	18 200
Transport	15 400
Commerce	28 300
Other services	9 970
Education, health, housing	17 740
Public Administration and Defence	8 820
Total	433 530

Source: Work Bank, China Long Term Issues and Options Annex E: China's Economic Structure in International Perspective Table C2 pp. 55-56 and Table D1 p.64.

Because of this relationship between the various sectors an increase in the production of one sector (sector A for instance) requires the increase in production of some other sectors i.e. the sectors which provide the raw material or semi-finished products needed by sector A.

This relationship between the various sectors can be shown by an input-output table such as the one presented in Table 15. It should be noted that in the table some economic sectors have been aggregated leading to broader sectors. The number of sectors is now 6 (Agriculture, Industry, Construction, Transport, Commerce, Non-Material Sector).

Table 15 can be read in the following way. Let first look at the *columns* and more precisely the column agriculture. It shows how the gross output of Agriculture (217,200 Millions yuans) is used. Part of it (31,760 Millions) is used in Agriculture itself (for instance as seed), part of it (66.960 millions yuans) is used in industry (for instance food industry), etc. All these intermediate uses lead to a total of 109,030 millions. The final demand of agricultural production is 108,170 millions; it is mainly constituted by household consumption (88,160).

If we now look at the *row* agriculture, we will see all the inputs into the agricultural sector. As we have already noted part of the production of agriculture is used by the agricultural sector itself. Agriculture is also using products coming from other sectors (for instance from industry: 24,360 millions). In total, the intermediate use by agriculture of production coming from other sectors is equivalent to 58,550 Millions.

From this table it can be seen that although the *gross output* of agriculture is 217.700, if we take into account the intermediate use by agriculture of production coming from other sectors and the *depreciation* of equipment used by agriculture, the *value added* by agriculture is only 156,600 millions.

Obviously this close relationship between the various sectors should be taken into account in planning. The growth of a particular sector does depend upon the sectors from which it gets its inputs.

The economic structure of a country can be characterized by the relative size of the various sectors of activity. From the data given in Table 16 one can have an idea about the Economic Structure of China in 1981.

The share of agriculture is quite sizable (36.1%). Among the industrial sectors machinery and textile are also quite important. If we group all the industrial sectors, including mining, the share is 39.8%. Finally as compared to other countries the service sector is relatively smaller, particularly in so far as commerce is concerned.

If we now look at employment i.e. the distribution of the labour force in the various sectors of activity, the picture somehow changes. The labour force employed in agriculture represents nearly 70% of the active population. Comparatively however the contribution of agriculture to production is much less. The average value added by worker may, indeed, change quite considerably from one sector to the other.

The economic structure of a country may change with the process of time. It is probable, indeed, that the growth of the various sectors may differ, some of them growing at a faster rate than the others. In general, the growth of the industrial sector tend to be higher than that of agriculture.

In the case of Japan for example it is interesting to compare the structure of production in 1960, 1970 and 1980. This is shown in Table 17. In 1960 the share of agriculture was 12.0%. It went down to 6.1% in 1970 and 3.9% in 1980. In other words, the share of agriculture in 1980 was only *one third* of what it was in 1960. This does not mean at all that production in agriculture has gone down. The volume of production has in fact

Table 15

Summary input-output table

	Agric.	Indus.	Construc.	Transp.	Commerce	Nonmat. Services	INTER MEDIATE	Depre-ciation	Value added	GROSS OUTPUT
Agriculture	31,670	24,350	500	820	1,150	60	58,550	2,050	156,600	217,200
Industry	66,960	241,040	6,350	14,940	14,920	1,220	345,430	11,870	178,500	535,800
Construction	3,500	44,770	4,000	2,140	1,610	80	56,100	800	18,200	75,100
Transport		7,060	4,000	510	760	60	12,390	3,300	15,400	31,090
Commerce	5,700	14,780	100	1,200	1,040	100	22,920	880	28,300	52,100
Nonmat. Serv.	1,200	24,810	1,150	1,040	1,770	450	30,420	5,300	36,530	72,250
INTERMEDIATE	109,030	356,810	16,100	20,650	21,250	1,970	525,810	24,200	433,530	983,540
Househ. Consum.	88,160	115,640		5,240	25,940	21,020	256,000			
Public consump.	860	15,420	2,100	2,120	270	49,260	70,030			
Investment	21,660	47,350	56,900	1,800	2,650		130,360			
Exports	2,990	29,510		2,460	3,440		38,400			
Imports	(5,500)	(28,940)		(1,160)	(1,460)		(37,060)			
FINAL DEMAND	108,170	178,980	59,000	10,460	30,840	70,280	457,730			
GROSS OUTPUT	217,200	535,790	75,100	31,110	52,090	72,250	983,540			

Table 16

Value added and employment by branch of activity, 1981

	Value Added (Millions)	%	Employment 000'	%
Agriculture	156 600	36.1	314 870	69.6
Metallurgy	14 650	3.4	2 850	0.6
Electricity	10 630	2.5	1 100	0.2
Coal	7 260	1.7	4 400	1.0
Petroleum	13 400	3.1	560	0.1
Chemicals	18 690	4.3	5 130	1.1
Machinery	37 770	8.7	18 190	4.0
Building materials	9 610	2.2	7 670	1.7
Wood	4 670	1.1	2 960	0.7
Food	18 040	4.2	4 210	0.9
Textiles and clothing	31 260	7.2	9 780	2.2
Paper	6 550	1.5	5 040	1.1
Other manufacturing	5 970	1.4	3 180	0.7
Construction	18 200	4.2	10 810	2.4
Transport	15 400	3.6	8 600	1.9
Commerce	28 300	6.5	14 570	3.2
Other services	9 970	2.3	3 840	0.8
Education, Health, Housing	17 740	4.1	20 370	4.5
Public Adm. and Defence	8 820	2.0	14 040	3.1
	433 530	100.0	452 170	100.0

Source: World Bank, *China: long-term issues and options*, 1985.

increased from 5,058 billions yens to 7,368 billions (in constant price). It only means that

the growth of agriculture has been slower than that of other sectors.

Table 17

Contribution of the various sectors of economic activity to GDP

Japan (1975 constant price)

billions yens

	1960	%	1970	%	1980	%
Agriculture	5 058	12.0	7 188	6.1	7 368	3.9
Mining	523	1.2	820	0.7	1 049	0.6
Manufacturing	9 25	22.0	35 142	29.8	69 462	36.8
Construction	3 046	7.3	10 957	9.3	15 259	8.1
Electricity, gas & water	809	1.9	2 360	2.0	3 659	1.9
Transportantion, communication	2 332	5.6	7 381	6.3	11 946	6.3
Trade and finance	10 912	26.0	29 551	25.1	55 485	29.4
Public admin. & Defence	3 452	8.2	5 741	4.9	8 602	4.6
Other branches	6 608	15.7	18 704	15.9	15 967	8.5
Total GDP	41 995	100.0	117 844	100.0	188 797	100.0

For manufacturing we have just an opposite situation. Its share has increased from 22.0% in 1960 to 36.8% in 1980. During the period the production of manufactured good was multiplied by *seven* .

Such rapid changes in the economic structure do require a corresponding change in the distribution of the labour force among the different sector i.e. the transfer of workers from some sectors to others. Mobility of workers may thus be a necessity in order to adapt to change in the economic structure.

Annex: International standard industrial classification

Major Division 1: Agriculture, Hunting, Forestry and Fishing

Division 11: Agriculture and hunting

Division 12: Forestry and logging

Division 13: Fishing

Major Division 2: Mining and Quarrying

Division 21: Coal mining

Division 22: Crude petroleum and national gas production

Division 23: Metal ore mining

Division 29: Other mining

Major Division 3: Manufacturing

Division 31: Manufacture of food, beverages and tobacco

Division 32: Textile, wearing apparel and leather industry

Division 33: Manufacture of wood and wood products including furniture

Division 34: Manufacture of paper, paper products, printing and publishing

Division 35: Manufacture of chemicals, petroleum, coal, rubber and plastic products

Division 36: Manufacture of non-metallic mineral products, except products of petroleum and coal

Division 37: Basic metal industries

Division 38: Manufacture of metal products, machinery and equipment

Division 39: Other manufacturing industries

Major Division 4: Electricity, gas and water

Division 41: Electricity, gas and stream

Division 42: Water works and supply

Major Division 5: Construction

Major Division 6: Wholesale and Retail Trade and Restaurants and Hotels

Division 62: Retail trade

Division 63: Restaurants and Hotels

Major Division 7: Transport, storage and communication

Division 71: Transport and storage

Division 72: Communication

Major Division 8: Financing, Insurance, Real Estate and Business Services

Division 81: Financial institutions

Division 82: Insurance

Division 83: Real Estate

Major Division 9: Community, Social and personal services

Division 91: Public Administration and Defence

Division 92: Sanitary and similar service

Division 93: Social and related community services

Division 94: Recreational and cultural services

Division 95: Personal and household services

Division 96: International and other Extra-Territorial Bodies

Major Division 0: Activities not adequately defined

Lecture 5

Analysis of the structure of qualified manpower

Ta Ngoc Châu

Objective of the analysis

By analysis of the structure of qualified manpower, we are refering both to the distribution of qualification in the labour force and to the distribution of occupation requiring specific qualification. The two approaches are slightly different. It is possible that a person having a particular occupation does not have the exact qualification required by his occupation. Conversely his qualification can be higher than what is really required by the occupation he has.

In the analysis of the structure of qualified manpower, one may think of two different objectives:

- to assess the present degree of mismatch between the type of occupation and the level of qualification of the persons having that occupation;

- to forecast the change in the structure of qualified manpower and the requirement of qualified manpower in the future.

Problem related to the relationship between occupation and qualification

When thinking of qualification, one often refers to the technical know how required by the occupation. For higher occupation, however, qualification can cover quite different aspects. There are at least three aspects which may be relevant:

- Leadership quality
- Problem solving and management skill
- Technical or technological competence.

Technical and technological competence can be related to specific training programmes and specialities. It is more difficult to do so for leadership quality and problem solving or management skill.

Measuring qualification therefore is a rather complex problem. It is often approximated with the education profile or the training received. The education profile, however, gives only the formal aspect of qualification. Independent learning, learning on the job, experience may play a very important part.

The relationship between qualification and occupation is not a fixed one. It depends upon:

- the sector of activity
- the technology used
- the internal organization of the enterprise
- the size of the enterprise.

The type of analysis which can be undertaken obviously depends upon the information available. Most often information refer to the distribution by occupation and the distribution by level and type of education. It is also possible to obtain information by sector of activity more rarely by size of enterprise.

Occupation classification

Occupation classification can be used for very different purposes. In higher educational planning the main purpose of an occupation classification is to facilitate the forecasting of the needs for different types of qualification in view of estimating the number of graduates required in different field of specialization. The real concern therefore is not only an occupation classification but the possible relationship between occupation and qualification. This, of course, should be taken into account in the design of the classification and in identifying the criteria used for classification.

A well known classification of occupation[9] the ICSO (International Standard Classification of Occupation) was developed by the International Labour Office. In this classification there are 8 major groups of occupation. These major groups are subdivided into minor groups (83) which are further subdivided into unit-groups (284).

The 8 major groups are as follow:

- Professional, Technical and Related Workers
- Administrative and Managerial Workers
- Clerical and Related Workers
- Sales Workers
- Service Workers
- Agricultural, Animal Husbandry and Forestry Workers
- Production and Related Workers
- Workers not Classified by Occupation.

The precise definition of each major group is given in the Annex.The above classification is given for information and as an illustration of what is meant by occupation classification and of the type of difficulty one encounters in designing an occupation classification. The ISCO certainly cannot be used as such in a specific country. The ISCO

[9] International Labour Office. International Standard Classification of Occupations. Geneva, 1968.

indeed has been developed 'to provide a systematic basis for presentation of occupational data relating to different countries in order to facilitate international comparisons'.[10] But each country needs a classification adapted to its own particular situation and requirement. In addition in ISCO 'qualifications (including educational attainment) have not been used as a basis for classification by occupation; performance of particular duties and tasks take precedence over possession of formal qualification'.[11]

As we have underlined previously, in the design of an occupation classification, the relationship between occupation and qualification should be kept in mind if one wants that classification to be useful for planning.

In more concrete term, an occupation classification should contain categories:

- which can be used, in a convenient way, for collecting reliable data (for instance from the enterprise)
- which are meaningful for the type of analysis which is to be conducted.

These two concerns can be, to some extent, contradictory. For ensuring that the data collected are reliable it is better to have a simple and clear classification so that the enterprise can identify easily to what category a specific worker belongs. For analytical purpose one may want a detailed classification which is, of course, complex and makes it difficult to collect reliable data. One has therefore to arrive at some compromise between the two concerns. It would be interesting to discuss the classification used in China from both point of view.

Level and type of education

For analytical purpose we also need to know the level and type of education received by workers in various categories of occupation and particularly those who have followed a higher education course.

Higher Educational System is often very diversified with many sub-levels and specialities and a large range of institutions. The problem may further be complicated by changes introduced in the structure of higher education with possibly the creation of new type of institutions.

The classification of sub-levels of Higher Education and type of speciality is of course specific to each country. We may devote some time during the workshop to deal with this problem in China.

[10] Ibid. p. 2;

[11] ibid. p. 9.

Annex: Definition of the major groups of the International Standard Classification of Occupation

(Extracts from International Labour Office, International Standard Classification of Occupation, Geneva, 1968, pp. 9-20)

Major Group 0/1: Professional, Technical and Related Workers

"This major group contains the greater part of the highly educated and trained personnel who carry out professional functions in scientific, engineering, medical, legal, teaching and other fields. Also included are technicians who generally work under the supervision of the more highly qualified professional workers and perform allied functions. In addition, this major group covers occupations such as those of creative artists, performers and writers, which call for the exercise of individual talents and, in many cases, for creative work."[12]

Major Group 2: Administrative and Managerial Workers

"Major group 2 consists of occupations primarily concerned with the formulation of policy or laws and public regulations (legislation) and interpretation of government policy, combined with important decision-making in governmental and non-governmental organizations, and with the direction and management of organizations and enterprises to ensure that the desired policies and objectives are followed."[13]

Major Group 3: Clerical and Related Workers

"This major group covers occupations which are commonly thought of as 'office jobs'; the great majority are primarily concerned with the setting-up and maintenance of records of all kinds relating to financial transactions, other business and industrial operations, personnel, correspondence, routine operations of government departments, and so forth. Also included are those jobs concerned with the handling and routing of messages, verbal or recorded, and those concerned with handling cash, often combined with record-keeping functions. Certain jobs of these types are carried out mainly outside the office to which the worker reports as in the cases of ticket collectors and conductors on passenger vehicles or postmen on delivery services. Supervisory occupations relating to office work and transport and communications service operations are also included here."[14]

Major Group 4: Sales Workers

"Although personnel of the 'sales' type are numerous, the range of tasks performed in the occupation concerned is comparatively narrow. Major group 4, covering occupationss in buying and selling goods, property and services of all kinds, therefore has a limited number of minor and unit groups."[15]

[12] ibid. p.9.

[13] ibid, p. 11.

[14] ibid. pp. 12-13.

Major Group 5: Service Workers

"Occupations in this major group are those concerned with performing housekeeping services relating to the everyday needs of families, other groups and individuals for meals, drinks and other living comforts, cleaning and caretaking services, personal care services, protective services for persons and property, and other miscellaneous services."[16]

Major Group 6: Agricultural, Animal Husbandry and Forestry Workers, Transport Equipment Operators and Labourers

"This major group covers a large fraction of the world's labour force. It is numerically the largest in developing countries and it continues to be an important one in some of the economically advanced countries."[17]

Major Group 7/8/9: Production and Related Workers, Transport Equipment Operators and Labourers

"This is the largest major group in terms of the number of minor and unit groups provided and, for most industrialized countries, the proportion of the labour force covered. The occupations covered are those associated primarily with the extraction of minerals, the processing of materials and the fabrication and repair of products, including buildings and other structures; occupations primarily concerned with operating transport equipment, earth-moving and material handling equipment; and non-agricultural labouring occupations."[18]

Major Group X: Workers Not Classified by Occupation

"Job-seekers who have not worked before may aspire to take up a certain type of occupation but they cannot be considered as already having a specific occupation. Hence, in census-type enquiries into the actual occupations of the population they must be classified in a group apart. For this purpose ISCO provides unit group X-10 (New workers seeking employment), Unit groups X-20 (Workers reporting occupations unidentifiable or inadequately described) and X-30 (Workers not reporting any occupation)."[19]

[15] ibid. p. 14.

[16] ibid. p. 14.

[17] ibid. p. 15.

[18] ibid. p. 17.

[19] ibid. p. 20.

Lecture 6

The diversity of higher education institutions in the People's Republic of China and profile of graduates

by B. Sanyal

Objectives of the analysis

In Lecture 5, it was mentioned that the higher educational system is often very diversified with many sub-levels and a large range of institutions. This diversity yields different types of qualified manpower. The objective of the present session is:

(a) to acquaint the participants with the rationale for diversity and the different forms which such diversification may take in programmes of higher education in general;

(b) to examine the diversity of the higher education system of China; and

(c) to analyze its consequences on the profile of graduates in the international and national contexts and in the province of Henan.

An analysis of the existing diversity and profile of graduates is needed in order to be able to estimate the future profile of graduates necessary for industrialization.

The rationale for diversification and the forms it may take

While formal institutions play the dominant role in higher education in general, they are by no means the only places where individuals may pursue explicit training objectives. A whole range of other educational programmes playing a great variety of roles have developed outside the formal system, which are the result of the growing awareness that the formal institutions of higher education are no longer capable of satisfying the whole range of increasingly diversified educational needs. These needs are the direct outcome of both the rapid pace of economic, technological and social change in contemporary society and a gradual broadening of developmental objectives. More specifically, diversification has taken place for the following reasons:[20]

(a) Educational objectives have become more diversified. (While educational objectives in the past were mainly cultural and a desire for knowledge for its own sake, today education must in addition satisfy the manpower needs of the economy, and be made available to all segments of society to achieve the objective of democratization. Education has to provide the means to gain a livelihood to all citizens).

(b) Diversity of 'new' client groups has also caused diversification. (One may mention here adult learners, disadvantaged and handicapped persons, unemployed youth, employees who need post-experience and refresher courses, and out of

[20] See Unesco/IIEP *Educational Planning in the context of current development problems*, Vol. I, Paris, 1983 pp. 38-40.

school youth).

(c) Widening of the process of resource mobilization, allocation and utilization has resulted in the diversification of higher education. (Resource mobilization now covers government sources (at different levels, e.g. national, provincial and local), private foundations, enterprises, students own funding, voluntary agencies and international organizations. Different sources have different types of allocation mechanisms and modes of utilization of resources).

(d) New modes of programme delivery and management have emerged to meet specific educational objectives, thus contributing to diversification. (These include open universities, workers' colleges, sandwich courses, television and radio universities, etc.).

(e) Underlying institutional diversification (to respond to local and regional needs, the needs of enterprises, etc.) has also been responsible for diversity in higher education. (This has taken the form of providing specific services to the community or interested groups. Co-operative programmes between institutions of higher education and industries also fall in this category).

These different reasons have given rise to different types of diversification, of which there are five major forms in higher education:

(a) Structure, e.g. part time/full time, single/full course, open admission, etc.

(b) Content: balance between theory and practice, more work experience, skill formation, orientation, new types of disciplines.

(c) Organizational methods: open university, university-industry co-operation, etc.

(d) Controlling authority: state, private, government sponsored, regional, local, etc., and

(e) Duration of studies.

There may be various other forms depending on the country.

In this respect the industrial sectors of the economy have played a significant role, especially in higher education. This is more common in industrialized countries because of the availability of training infrastructures, the incapability of formal institutions to provide the necessary skills in a short period of time, the need for job specific training and to relate training more closely to the needs of the job. Some examples of the different forms prevalent in different countries are given below:[21]

The increasing need for workers to participate in management, the growing tendency of companies to meet their employment needs by upgrading the work force within the company rather than depending on the external labour market, and the specific types of skills needed by different industries have been the motivating factors for the organization of adult education in the Federal Republic of Germany; as a result, about 40 per cent of all the firms employing 50 employees or more had provision for such education as early as 1974. Training could take place, depending on the purpose, either 'on the job' in the

[21] Sanyal B.C. *Alternative Structures of Higher Education and the World of Work*, International Review of Education, Vol.XXVIII, 1982.

firm or 'off the job' with paid educational leave.

The chronically high level of unemployment in Sweden has encouraged the development of recurrent education among youth there, in addition to the stimulus provided by experiments in 'industrial democracy' for increasing workers' participation in decision-making on the conditions of work. Swedish universities have formally recognized work experience as a criterion for admission, in place of upper secondary school certificate, for those aged twenty-five and above. A joint project between the University of Lund and a regional trades union has formalized an education-employment linkage whereby course content and teaching are adopted to trades union needs and the union supports research relevant to its interests.

In the United Kingdom, recurrent education has developed against a background of skill obsolescence, lagging productivity, high unemployment among youth, shifts in occupational distribution and changing labour/management relations, and the Employment and Training Act of 1973 has given rise to courses making education more responsive to the world of work. In the mid-seventies, around two-thirds of the total labour force was covered by the Industrial Training Board, responsible for this training. In addition to the ITB's, there is also the programme of Training Within Industries (TWI), offering short courses under the direct responsibility of the Government. Medium and long-term 'off the job' recurrent education is provided in the Training Opportunities Scheme (TOPS). These programmes have been so popular that between 1973-1976, the number of courses nearly doubled. Flexible hours, compressed work courses and part-time employment enable the workers to undertake such training more easily. The Integrated Graduate Development Programme (IGD) located at six university centres and the 'Austin Rover course' at Warwick University, UK, discussed in an earlier session[22] are also good examples of diversity of the delivery system of higher education in this country.

In the United States, in 1975, 7.500 of the largest private employers spent over US$2 billion on employee education; of this total, internal company courses accounted for US$1.6 billion, excluding the cost of employees' wages and salaries while they were learning, and the rent and other overhead expenses. In all, 45,000 people were engaged on a full-time basis, as instructors, programme developers, administrators and evaluators. The type and scope of the training today varies from industry to industry, but the core of the programmes is active student involvement through simulation exercises and end-of-course critical evaluation, individually-oriented course content, duration and instructional method, the increased use of programmed materials, advanced instructional technologies and the appreciation of the student's sensibilities, behaviour and attitude. The Fund for the Improvement of Post- Secondary Education, a Federal Government fund, has been established to relate education to work with the objective of providing more avenues for routing out-of-school adults back into education and through education to work. The Fund works in co-operation with voluntary agencies, educational associations and institutions for higher education.

In Eastern European and many developing countries, there are similar programmes for the training of the work force. In some of them, investment in such training will exceed investment in formal education.

Discussions on diversity of higher education would remain incomplete if we did not include two innovations that are being tried out in the United Kingdom and in the United States, respectively, the 'Open University' and 'Co-operative Education'. The Open

[22] See Reiff, Hans: Lecture 3 (page ?)

University was established in 1969 with the primary objective of giving to those who would not otherwise have access to it, the opportunity to pursue higher education. Provision was made for 'open entry' admission of mature students (21 years and upwards) as part-time, non-residential students who would work at home in their spare time. The instruction can lead to a degree (BA Ordinary or Masters), but other, non-degree programmes are also available. 'Foundation courses' are provided to most students, but those who have the regular qualifications for following a particular programme are exempt. Instruction takes different forms. A variety of correspondence units and television and radio broadcasts provide students with information and guidance in a standard package. The packages are prepared by a course team composed of regional and central academic staff, the BBC, and educational technologists. In addition to working at home, students can attend, on a voluntary basis, 'study centres' located throughout the country, usually in other educational institutions. These centres are the focal points for the undergraduate students' meeting with their tutor/counsellors, who take the role of a general educational adviser at the local level throughout the student's educational course. Tutor-marked assignments by correspondence are the major means of improving upon the students' work. Computer-marked assignments complement these. Degrees are awarded to students who have achieved a given number of credits in the programme. In addition to continuous assessment through assignments, every course has a final examination for the degree. Since the Open University was established, such distance learning systems are spreading over many countries in the developing world centred around the correspondence courses already in existence. This new avenue is providing many individuals with a chance to upgrade their social roles as well as to pursue higher education for its own sake.

The American programme, 'Co-operative Education', is an academic strategy that integrates on-campus classroom study with off-campus work experience. Although the term is more common in the United States, such programmes are prevalent in many other countries. Students in co-operative education alternate between periods of study in their colleges and universities and periods of employment in business, government and non-profit-making organizations. Employment areas are directly related to academic areas. Depending on the situation, such work experience is given due academic credit and may be remunerated (e.g., USA, United Kingdom) or honorary (Federal Republic of Germany). The main characteristic of these programmes is that they are organized from and within the education system as an attempt to develop a closer relationship between the education system and the world of work.

The diversity of higher education in the People's Republic of China

The process of diversification of higher education in China began in the early years after liberation. The principal objectives were democratization and making education more relevant to economic needs for skills. One can identify two broad categories in the higher education system: (1) Regular Higher Educational Institutions and (2) Adult Higher Education Institutions.

The *Regular* Higher Educational Institutions consist of two categories:

(i) *Conventional universities* under either provincial or national management. In 1983 there were 805 such universities:[23] 514 of them under provincial control and 291

[23] The number had risen to 1107 by 1985 (see Cheng Kai Ming: Reform of Higher Education in Mainland China (mimeo) May 1986, University of Hong Kong.

under national control. Of the *29 nationally controlled*, 13 were comprehensive in nature and approximately 100 were controlled by the State Education Committee, 80 by the Ministry of Agriculture, Animal Husbandry and Fisheries, while the remainder were under other ministries and agencies. 96 of the national universities are designated as key universities, 26 of them under the control of the State Education Committee. Of the *514 provincial universities*, 23 were comprehensive, 202 were normal universities for teacher education, 57 were technical universities, 88 medical, 45 agricultural and 99 others offered specialized programmes in the Fine Arts, Physical Education, Commerce and Foreign Languages. The graduates of provincial universities are usually assigned to jobs in their respective provinces. The 202 normal universities are subdivided into two categories: major which number about 70 offer 4 year degree programmes and some offer graduate programmes as well. They train teachers for upper secondary schools. The other category, minor normal colleges, offer 2-3 year non degree programmes for the training of lower secondary school teachers.

(ii) *Polytechnical institutions.* These newly established short term vocational universities, also called municipal universities, are designed to produce middle level technicians to meet local (as opposed to national or even provincial) manpower requirements by offering two or three year courses of study. They were started in 1980 with 17 such institutions. In 1983 the number had grown to 55 and had reached over 80 by 1985.

One important distinction between conventional universities and polytechnics is that the graduates of the former are assigned jobs and those of the latter are not guaranteed jobs but are assisted by local services to find employment. The Polytechnics also, in general, do not provide residential facilities for students, they may charge fees to students and they impart training based on local needs articulated through close co-ordination between local enterprises and provincial planning commissions.

In 1983 the total enrolment in Regular Higher educational institutions was 1.2 million. Total staff numbered 763,000, of which full time teachers constituted 40 per cent.

Distribution of enrolment by field of studies is presented in Table 18.

Table 18

Distribution of students by field of study in 1983

Engineering	35
Teacher training	26
Agriculture	5
Humanities	5
Natural sciences	7
Finance and economics	6
Medicine and pharmacy	12
Forestry	1
Political science and law	1
Physical culture	1
Art	1

The second broad category of higher education institutions in China is the *Adult Higher Education system* This comprises four principal categories (i) Television

Universities, (ii) Workers' Colleges, (iii) Correspondence, special and evening programmes, and (iv) others.

(i) *Television universities.* The Central Radio and Television University (CRTVU) and 28 provincial television universities (PTVU) were established in 1979. CRTVU is managed by the State Education Committee and PTVUs by provincial governments and local enterprises. They operate about 500 branch schools, study centres and work stations and 14 000 TV classes in factories and work units. Total enrolment was approximately 500,000 in 1983, half of them full time. More than 90 per cent of students were employees and took an entrance examination for enrolment. There were approximately 37,000 teachers, of whom 30 per cent were full time. CRTVU broadcasts 33 hours of educational programmes a week through the national television network. It distributes audio cassettes and booklets and organizes examinations. It provided 50 courses in 5 science and technology specialities in 1984 and 40 courses in 5 economic specialities. Some PTVUs offer additional courses of their own. Work stations provide face-to-face tutoring with instructors recruited from factories and nearby regular higher education institutions. Branch schools and work stations also provide laboratory facilities where available, otherwise laboratory work is done in nearby colleges and universities.

(ii) *Workers' Colleges.* In 1981, the Government announced that 1.5 per cent of the total wage bill of workers and staff should be used for education. Large scale enterprises and state agencies intended to use these resources for the higher education of their workers under their own responsibility, to meet the requirements for manpower, by means of in-service training. Workers may engage in full time study with the permission of their work units but they are guaranteed at least four hours of spare time for study per week under the general policy of workers' education.

There are three categories of workers' colleges:

(a) Regional Workers' Colleges to train qualified personnel for local factories.

(b) Specialized department workers' colleges to train professional personnel for factories, mines and other enterprises in a specific sector, especially to improve technologies of production and modernize the sector, and

(c) Factory-run workers' colleges for training professional and technical personnel needed to increase the level of production, of mechanization and specialization of workers.

The number of institutions in the first category constitutes 10 per cent of the total with an enrolment of approximately 37 per cent; the second category constitutes about 53 per cent of the whole with an enrolment of 41 per cent and the third category represents 37 per cent with an enrolment of 22 per cent.[24]

By 1983, China had over 800 workers' colleges with an enrolment of about 170,000 students.

In addition to workers' colleges run directly by enterprises, mass organizations, provincial and municipal bureaus of education, as well as certain regular institutions, offer tailor-made training programmes for urban adult workers.

[24] Central Institute for Educational Research, Beijing/IIEP: Adult Higher Education: A case study of Workers' Colleges in the People's Republic of China, IIEP (mimeo) draft 1985.

Entry to the workers' college degree programmes is based on senior middle level school graduation, two years' work experience and in general an upper age limit of 35. The course structure for these programmes is very diversified. Specializations offered are closely geared to the requirements of the work place, especially to raising the economic performance of the workers' employing agency. Enrolment in workers' colleges varies a great deal. There are colleges with an enrolment of 75 and also some with as many as 5,000 students. According to available statistics, Harbin Spare Time College had a student/teacher ratio of 32:1 compared to Taiyuan Xishan Mining College which had a ratio of 3.4:1 in 1984.[25]

(iii) Correspondence departments of higher education and evening colleges attached to regular institutions of higher learnings.

These are of two categories, one for degree courses, the other for diploma courses. The former offers five to six years' specialities in science, engineering, forestry and agriculture; the latter offers four years' specialities in the afore-mentioned fields of study as well as four years' specialities in medical science (excluding medical treatment); three to four years' specialities in the humanities and social science. In addition, single-course classes are accessible to administrators of all types so that they may have the opportunity to up-date their knowledge in a specific subject more effectively.

Correspondence departments take students primarily from among employed people, and try to impart to them the knowledge needed for their jobs. According to the regulation formulated by the State Council, starting from September 1979, in all the institutions which have been evaluated and approved by the Ministry of Education, the students who have completed the courses and passed the required examinations, will receive their certificates and be treated in the same way as regular college graduates.

In 1983, 378 regular universities and colleges in 26 provinces, municipalities and autonomous regions have set up correspondence departments or evening colleges. Of these, 155 have only correspondence departments, 169 have only evening colleges, and 54 have both correspondence and evening colleges. In addition, there are three correspondence colleges independently managed by local departments of education, with more than 8,000 students. Total enrolment in this category of higher education institution was approximately 300 000 in 1983; 82 per cent of this enrolment followed at least 3 year college programmes. The students have a study load of about 15 hours a week. However, only 50-60 per cent of the students successfully complete their programmes of study.

(iv) *Other categories of adult higher education* : these include universities for peasants (4 in 1983), educational colleges (36 in 1983), institutes for upgrading secondary school teachers (268 in the same year with a total enrolment of 165 315), independent correspondence colleges (3 with a total enrolment of 8 114) and administrative staff training institutes (15 with a total enrolment of 2,020).

There is also a programme of examinations for independent study for adults at higher education level. The system is a combination of individual study, social help and national examinations. The independent study is undertaken by means of face-to-face teaching and by correspondence. Examination committees have been set up for these self learners without any restriction as to occupation, age, school record and number of subjects for study. Examinations are now organized for 30 specialities in both science and arts based fields. During the second half of 1983 the number of examinees stood at

[25] Ibid. p. 77.

188,000. More than 115,800 single course certificates had been issued. The qualified individuals who pass a four or three year degree course or a single course examination, are issued with the relevant bachelor's degree, diploma or specific course certificate. Graduates are supposed to enjoy the same consideration as the regular higher education graduates.

In addition, there is also the programme of studies abroad. In 1983, there were 2 633 students abroad sponsored by the Ministry of Education alone.

The above discussion shows the diversity of the higher education system in the People's Republic of China. In the following section the profile of graduates of higher education institutions is discussed.

Profile of graduates

The most important information to relate the development of higher education with industrial development in a country is the profile of graduates. This is because such a profile enables the types and levels of education and training to be organized to meet the needs of jobs. However, this should not ignore the phenomenon of substitution between occupations/specializations.

The profile of graduates in China will be discussed for the year 1983 according to the following characteristics: type of course and field of study for regular higher education institutions; for engineering the profile will be given by sub-field of study. For Television Universities the profile will be given for full course and single course programmes and the remaining Adult Higher Education Institutions will show the profile by full-time and part-time programmes, except for evening schools and correspondence divisions of regular higher education institutions, where only the total number of graduates will be given. No statistics on graduates of independent correspondence colleges and administrative staff training Institutes are available. Given their limited role, the discrepancy in coverage will not be significant.

It may be observed from Table 19[26] that three out of four graduates of regular higher education institutions are normal course graduates, i.e. with at least a Bachelor's degree. The largest proportion of these are in engineering (39 per cent) followed by medicine and pharmacy (19 per cent) and teacher training (15 per cent). For short cycle courses the largest proportion of graduates came from teacher training colleges (64 per cent) followed by engineering (16 per cent). The number of graduates of both normal and short cycle courses is highest in Engineering (33 per cent) followed by teacher training (27 per cent) and medicine and pharmacy (17 per cent).

In the engineering field (Table 20), the largest number of graduates specialized in mechanical engineering (30.5 per cent), followed by radio and electronics (22.7 per cent) and civil engineering and architecture (10.9 per cent). The above analysis shows a significant emphasis on engineering education in China. In effect China has the largest proportion of students in engineering in the world, according to available countrywide statistics!

[26] The source for Table 19, 20 and 21 (and for the statistics cited in this section) is Achievement of Education in China-Statistics 1949-83 Department of Planning, Ministry of Education, the People's Republic of China, 1985.

Table 19

Percentage of graduates by type of course and field of study

Field of study	Percentage in normal courses	Percentage in short cycle courses	Percentage in all types of courses
Engineering	39	16	33
Agriculture	5	4	5
Forestry	1	*	1
Medicine and pharmacy	19	9	17
Teacher training	15	64	27
Humanities	6	2	5
Natural sciences	8	1	6
Finance and economics	4	3	4
Political science and law	1	1	1
Physical culture	1	*	1
Art	*	*	*
Total	100	100	100
Total enrolment	252 571	82 773	335 344
Total percentage	75	25	100

* less than 0.5 per cent.

Among adult higher education institutions, the largest proportion of graduates came from TV universities, followed by those from workers' colleges (see Table 21).

In order to make the profile of graduates more useful for macro-planning purposes, knowledge about the specializations of graduates from adult higher education institutions would be necessary. However, if the forecasts of needs are based on individual enterprises, such information may be available to the responsible authorities and used for planning the development of such programmes, since most of the students of these institutions belong to some employing agency.

Diversity in an international perspective

Table 22 gives a comparative analysis of the profile of graduates for nine countries, including China. The disciplines are those used by Unesco for international comparison purposes. The following facts emerge from the table:

(a) China has the second largest proportion of engineering graduates in the group.

(b) She has the largest proportion of teacher-training colleges in the group.

(c) India has the largest proportion of Arts based graduates whereas China has the lowest proportion of such graduates.

(d) China has the smallest number of graduates per million population.

Table 20

Percentage of engineering graduates by sub-field of study

Sub-field of study	Percentage
Applied geology	4.0
Mining	3.1
Power engineering	3.4
Metallurgy	4.3
Mechanical engineering	30.5
Electrical machines and instruments	2.0
Radio and electronics	22.7
Chemical engineering	7.4
Grain processing and food industry	0.9
Light industry	3.0
Mapping, surveying and hydrology	0.7
Civil engineering and architecture	10.9
Transportation	2.8
Telecommunications	1.3
Others	2.5
Unclassified	0.3
Total	99.8

Note: Total does not add up to 100 due to rounding.

Table 21

Number of graduates by type of adult higher education institutions in 1983

Type of Institution	Full time	Part time	Total
Radio and TV universities(a)	67 905	61 286	129 191
Workers' colleges	22 434	10 768	33 202
Evening schools & divisions of correspondence in regular institutions	-	-	10 870
Universities for peasants	387	-	387
Educational colleges	2 786	1 497	4 283
Upgrading institutions for secondary school teachers	11 053	36 922	47 975

(a) For radio and TV universities, the types of courses relate to full course and single course instead of full and part time.

Note: Source of Tables 2, 3 and 4 and other statistics cited in the text is Achievement of Education in China-Statistics 1949-83 Department of Planning, Ministry of Education, the People's Republic of China, 1985.

It should be emphasised that such international comparisons, in spite of the efforts of international organizations to standardize the structures and classifications, still deserve to be interpreted with caution.

Some problems of diversity

While diversification of the education system has a lot of advantages, as indicated in section 6.2, it also has certain disadvantages. These are:

(a) Problem of co-ordination. A large network of delivery systems needs proper monitoring and co-ordination to safeguard quality, achieve economies of scale and increase mobilization in case of structural changes in manpower needs.

(b) Training carried out by enterprises or by the sectoral ministries tends to be excessively narrow and job specific. Mobility among workers is restricted.

(c) Diversity creates the problem of converting educational output to occupational needs.

However, the advantages of such diversity appear to outweigh the disadvantages which can be overcome by a proper monitoring mechanism.

Table 22

Profile of graduates by country and by latest available year

Discipline	China (1983)	Japan (1982)	France (1981)	Fed. Rep. Germany (1981)	United St. of America (1978)	India (1983)	Korea (1981)	German Dem. Rep. (1981)	United Kingdom (1981)
Education science & Teacher training	26.0	11.8	5.4	13.9	10.1	9.9	12.2	12.1	9.4
Humanities, etc.	5.4	16.4	22.7	2.4	5.7	1.7	6.4	1.7	10.9
Fine & applied arts	.4	3.5	1.0	1.5	3.3	0.1	6.4	0.8	3.9
Law	.9	-	13.6	3.5	2.2	3.3	1.2	0.7	3.4
Social & behaviour sciences	-	29.4	6.6	12.1	9.5	45.8	4.9	4.2	11.6
Communication & business Administration	5.3	-	8.7	2.9	21.1	13.6	9.1	8.6	9.8
Mass communication	-	-	.8	.2	2.6	0.2	0.8	0.5	0.3
Home economics	-	9.7	.4	.3	1.2	0.3	2.7	-	0.1
Service trades	-	-	-	-	0.3	-	.0	-	
Natural sciences	4.8	1.8	13.7	3.6	5.0	15.1	3.5	1.3	14.0
Mathematics & composition	2.9	.6	1.0	1.2	2.7	/	0.9	0.6	3.5
Medicine & health	16.4	4.9	9.9	26.5	9.2	1.9	7.6	16.1	5.7
Engineering	30.0	16.4	5.6	9.7	5.6	2.5	33.2	15.1	19.5
Architecture & town plan.	.0	-	.7	1.6	0.7	/	0.2	0.2	1.7
Trade, craft, etc.	-	-	6.2	-	3.3	/	2.4	-	0.3
Transport & communication	1.4	.0	.2	-	0.1	/	1.1	-	-
Agriculture, forestry & fish.	5.7	2.6	1.2	2.0	2.0	1.1	6.3	4.1	1.6
Other	.8	2.9	2.3	18.5	15.4	4.5	1.1	34.0	4.3
	100	100	100	100	100	100	100	100	100
Graduates per million population	337	4 809	4 960	3 309	7 723	1 528	4 375	6 845	2 944

Source: Unesco Statistical Year Book 1985.

Lecture 7

Trends in new admission and in enrolment in the various specialities of higher education

by S.K. Chu

Objective of the analysis

Data and information on education are becoming readily available and accessible these days. The appearance in 1985 of the publication: 'Achievement of Education in China - Statistics 1949-1983' was certainly a milestone in the dissemination of information on educational activities in China. It has paved the way to the strengthening of data collection efforts and more widespread use of information for decision-making.

The quality of data has also considerably improved during recent days, in terms of accuracy, timeliness and comprehensiveness, thus providing a solid information base for educational policy, planning and management.

The rapid on-going accumulation of data and information has not been matched, however, by a corresponding upsurge of efforts in information analysis and use. Data that have just been collected can be appropriately compared to raw mineral ores, which needs to be repeatedly processed and refined in order to extract the essential information.

One could therefore hardly over-emphasize the importance of, on the one hand, systematic data processing in order to sort and classify raw data into organized storage for easy retrieval; and on the other hand, of analyzing and extracting the relevant information for synthesis into information for decision.

The following is a modest attempt to illustrate some of the what's and how's in data analysis as applied to the data on higher education included in the above-mentioned publication.

Data scope

The type of analytical methods and techniques to be employed is to a large extent determined by the type of data available. Inversely, approaches and methods in analysis also generate requirements for the collection of new types of data.

Basic data on higher education can be classified into three main categories: data on institutions; on students, the object of the educational process; and on resources such as personnel, funds, facilities and equipment. Considered under the systems approach, education is treated as a process that takes in inputs in the form of students, adds on resources so as to process the students to produce the output, namely the graduates.

Higher education in distinction to other levels and types of education and training has a specific and diversified structure—in terms of fields of study and sub-levels. Data on students and resources should therefore be classified accordingly. That is why data on

higher education, apart from the usual classifications of students by sex, age, and grade, are also distributed by field of study, by type of specialized institution and by sub-level within the higher educational system.

It was observed that furthermore in China students are classified by normal and short-cycle courses. The level of sophistication of data classifications for other types of data on higher education such as personnel, finance, facilities and equipment, are quite high, especially considering the regularity and coverage of data collection, as well as the geographical dispersion of the higher educational institutions.

This does not exclude, however, the need at all levels of the higher educational administration of information on factors that affect the provision of higher learning opportunities. Data on the target population aged for example from 15 to 30 years old, classified by sex and age (or age-groups), and on its past and predicted future trends, may provide the first basis for gauging and enlarging the coverage of higher education.

More and more, the employment pattern and the economic production structure are found to be determinant factors that come into play in the planning of higher education. It is with the aim to optimize the returns of training of qualified manpower that demand arises for co-ordinated planning between the education sector and other productive and employment sectors.

A third major area of information is related to environmental factors that affect the access of young people to higher education and their success in the educational process. Relevant data may include those related to student's family background and household conditions, as well as the availability of various social services such as health, transport and lodging facilities.

Although some countries have been introducing measures to enable direct access to higher education, it is still very much dependent on the level of activities in secondary education. Information on the annual output of secondary school graduates, and the rate of their transition into higher education as compared to engagement in gainful employment, are also crucial factors to be considered in the planning of higher education.

Methods of data analysis

Three major dimensions govern methods of analysis of data on higher education. The first dimension relates to its internal structure and distributions, as well as the inter-relationships between data categories. This refers first of all to the study of the distribution according to categories and classifications such as: percentage distribution of students by sex, age or field of study; full-time teaching staff by teaching field; and school building space by purpose, etc.

Another aspect of this method is the expression of interrelationships between data elements, either in terms of ratios such as the number of students per teaching staff, average enrolment by type of institution, new admission as a percentage of total enrolment, etc.; or through the application of regression analysis in establishing the relational models between data categories.

The second dimension is concerned with external distributions in relation on the one hand to the geographical dispersion of educational activities—by major regions, province/municipality, and within individual provinces; and on the other hand, to the distribution

by population groups such as the ethnic minorities and urban-rural populations, and socio-economic sectors such as the extent of their respective involvement in the provision of higher education.

It should be mentioned here that data analyses performed along the two preceding dimensions are static in nature, which deal with the situation at a fixed point in time. There is a third dimension which consists of the dynamic analysis of data through time. It is by studying the variations over time that one can obtain a clear understanding of past progress and trends, and then to project for the future. This is a vital aspect of the use of data analysis in assisting the planning of educational activities.

In actual data analysis, all three methods or dimensions are applied, in different combinations accordingly to the type of data and the objective of analysis. And the level of skill of the data analysts is very often determined by the dexterity with which he/she make combined use of these possibilities. For example, the series of pie-graphs in Chart I in the Annex to this paper showing the percentage distributions of respectively new admissions, enrolment and graduates by field of study for the years 1965, 1976 and 1983 are used to study the changes in the patterns by field.

Therefore, statistics may be mainly presented in two ways: tables or charts. Again, they are usually used in combination. More and more nowadays, however, data analysts are shifting towards increased use of charts and graphical presentations as such visual displays have been found to be more intuitive and thus more effective for illustrative purposes, as compared to tables with rows and columns of figures. With recent advances in computer graphics facilities, this practice has been predicted to be further expanding in the future.

Data analysis serves two additional purposes. The first is the detection and identification of errors in the original data. This often happens during the summing up of detailed data when we discover that the figure for total that was originally reported is different from the sum obtained through the calculations. The error can then be traced, identified and corrected. Similarly, one may notice during the plotting of a line graph that a few of the data points are found a long way off the main trend. This may indicate yet other aberrations in the data.

New data needs may arise during data analysis. The deeper one goes into the data, the more missing links one will find which could only be filled by the collection of additional data. It is through this process of feedback demand that one can identify new areas, sources and forms of information, thus renewing and streamlining information work. These two aspects should therefore be constantly keep in mind during the analysis of data.

In what follows, some preliminary analyses of the statistics on higher education in China contained in the publication: 'Achievement of Education in China - Statistics 1949-83' are included to illustrate how the methods mentioned above could be applied.

Therefore, looking at the tables on enrolment, new admissions and graduates by field of study on pages 95, 97 and 99 respectively(see Annex), our first reaction will be to study the percentage distributions by field of study, and the variations over time. These percentages are shown in the tables on pages 96, 98 and 100 (see Annex). They are further visualized in Chart I which illustrates the situation through three series of pie charts for the three types of data.

Looking at the pie graphs in the horizontal direction, it is found that the patterns of distributions by field of study of new admissions and enrolment are very much similar for the same year. The patterns for graduates may deviate slightly from the two others, mainly owing to the time-lag between admission and graduation, when some changes might have occurred in the mean time. Study of the pie graphs in the vertical direction revealed certain shifts in the relative structure by field, although on the whole it remained stable throughout the 18 years covered. The most notable changes were found in the engineering field, where the proportional share has decreased from more than 40% to barely one-third of the total. The share of teacher training has on the contrary increased considerably from around 15% to about 20%.

Engineering

Engineering, despite its decline in percentage share, still managed to maintain throughout the past years the highest share of students, new admissions and graduates, to the extent of one quarter to more than one half of the corresponding national totals. This is one of the salient features of higher education in China.

As far as the general student trends in the engineering field are concerned, Chart II in the Annex shows by means of two graphs the variations from 1949 to 1983 in enrolment, new admissions and graduates, both in absolute figures and as percentage share of the total. It can be seen that enrolment climbed exponentially during the 1950s, to reach its first height of 389 thousands in 1960. The vertiginous growth from 1957 to 1960 was however reversed from 1961 onwards, to decrease steadily to below 234 thousands in 1966, before plunging to its all time low of 12 thousands in 1970.

It is interesting, though, to notice that the direct extension of the enrolment trend from 1949 to 1957 actually meets the 1966 level, which apart from pure coincidence also leads us to believe that the 1983 level of enrolment, although re-established in only since the past few years, is still far from rejoining the general trend. This is confirmed by the rather stable situation in terms of percentage share in recent years, which hovers around one third of the national total.

Except for a few abnormalities, around 1957 and 1978, new admissions to engineering seemed to follow the enrolment pattern, and kept within appropriate proportions. But the trend in graduates has witnessed some surprising fluctuations since 1977, which does not correspond at all to the enrolment, even though taking into consideration the time lag between admission and graduation. This curious phenomenon was the more accentuated for the percentage share, which dropped by more than 20 percentage points from 1980 to 1981.

As mentioned above, the analyst's immediate reaction will be to check more in depth into the detailed data, where it was found in the distribution of engineering graduates by sub-fields on pages 90-91 that the fluctuations were across the board during the same year for all sub-fields, and not for isolated cases only. This may lead to the need for more in-depth inquiries into the factors that have caused these fluctuations.

Teacher training

Another approach to the verification of the anomalies in graduates in engineering is to check whether the same happens to all other major fields of study. It was actually found out that similar fluctuations appeared during the same period for most of the other fields, with the only noticeable exception of teacher training (Chart III).

Teacher training has consistently accounted for the second largest share in terms of students—to the extent of more than a quarter of the total all fields in recent years. In absolute figures, the increase in enrolment between 1976 and 1980 was extremely fast, from about 110 thousands to 338 thousands, i.e. more than tripled. This may in part be attributed to the upsurge in new admissions to teacher training in 1977 and 1978, which returned to the normal trend in 1979. The on-going trend provides for an average annual increase in new admissions to the order of some 10 thousand students.

Equally noticeable is the recent trend in graduates from teacher training, which corresponds closely to those for enrolment and new admissions, but with a time lag of two years in relation to the former, and four years to the latter. This is a reflection of the ideal training process and quantitative outcome. It also in some sort demonstrated the internal efficiency of the teacher training institutions.

There are however two precautions at this stage. The first is related to the high percentage share of teacher training. This field of study is conducted in many countries in post-secondary teacher training colleges at a level of education that is generally termed higher education leading to a diploma or certificate not equivalent to a university degree. According to the International Standard Classification of Education (ISCED), this correspond to ISCED level 5. The high proportion of students in teacher training may therefore be due to their concentration at the ISCED 5 level, which may not be comparable to full-time studies in other specific fields in the universities. A more refined analysis of the distribution by field should therefore be based on classifying students in higher education by the ISCED levels 5, 6 and 7, where level 6 refers to university studies leading to a first degree while level 7 corresponds to graduate studies.

The second remark relates to the educational cycles clearly demonstrated in this section, where in the stable situation, enrolment and new admissions should maintain between them a fixed proportional ratio. The same type of relationship may also exist between graduates and enrolment on the one hand, and graduates and new admissions on the other, but both with a certain time lag corresponding to the number of years of study. These relationships were clearly shown in teacher training, but not for most other major fields. In this type of data analysis, any trends that deviates from the standard correspondences should therefore be subject to further investigations.

Agriculture

While following trends more or less similar to those of engineering, the agricultural field resembles teacher training in the correspondence between graduates and new admissions for recent years. Similar linkage between graduates and enrolment may be seen, but is not as conspicuous. This clear relationship bears similarity with teacher training, and it may also be due to the diploma-type training offered.

In terms of magnitude, one can see from Chart IV in the Annex that enrolment in agriculture has not yet regained the highest level of 1961, when there were some 83 thousand students. The same goes for the number of new admissions which, however, has re-established a stable increasing trend.

What is especially remarkable is the wide fluctuations in agriculture's share of graduates. These oscillations were particularly strong during the past ten years, although there are signs of certain reductions in the span. Apparently, measures should be introduced in the agricultural colleges as a result of more in-depth study of the causal factors, so as to stabilize the annual output. In contrast to graduates, trends for the percentage share of enrolment and new admissions have stabilized since around 1978.

Growing fields

Phenomenal increases in enrolment and new admissions have occured both in finance and economics as well as in political science and law. As shown in Charts V and VI, the size of new admissions to finance and economics in 1983 was five times the highest previous level—to situate at almost 30 thousand. Enrolment has reached an all time high of 71 thousand students in 1983. In political science and law, new admissions increased seven times in just five years to reach about 7 thousand in 1983; and total enrolment has already topped 18 thousand.

The most noteworthy sign was somehow the corresponding increases in percentage shares. These can be seen in related charts where there is the sharp rise of the curves for enrolment, new admissions and graduates since 1978. It seems therefore that the social sciences are enjoying a massive revival in China. The question remains as to how on the one hand optimal use could be made of the eventual rise in graduates, and on the other hand to adapt related training to the immense needs in qualified managerial personnel.

The other fields

For the remaining fields of study, medicine and pharmacy (Chart VII) have been able to maintain a very stable percentage share of students, although a slight decline in recent years can be noticed. Total enrolment attained a historical height of 164 thousands in 1982. And the number of graduates in 1983 was 55 thousands. All in all, recent enrolment and graduation levels have rejoined the overall trends in the past.

The natural sciences (Chart VIII) have had variations very much similar to engineering, with the exception that past fluctuations in absolute numbers and percentage shares have been even more acute, especially in the annual share of graduates. It seems also that recent enrolment level has not yet reached the general trend level. Patterns in forestry resembles basically those in agriculture and humanities, art and physical culture are comparable (Charts IX, X, XI and XII).

Overall trends

Trends in enrolement, new admissions and graduates from all fields of study of higher education in China since the past 35 years have been characterized by six periods(see Chart XIII). The first period covers 1949 to 1957, when steady and organized growth in all fields took place. This was followed by the huge upsurge of the 1957-60 period, to reach the peak in 1960. The six years thereafter witnessed re-adjustments to the excessive pressure on the higher educational system, created by the artificial boost exerted during the previous period. Student levels were gradually reduced, to reach in 1966 the level which correspond to the extension of the trend in the first period.

And then the Cultural Revolution broke out in 1967, during the height of which most of the higher educational institutions were closed. Enrolment, new admissions and graduates fell to the lowest point in 1970-71. That was the fourth period.

Beginning in 1972, higher education was slowly re-established and one could see steady increases in enrolment and new admissions. Their combined effect on the level of graduation was not apparent until the middle of the 1970's. Then, from 1976 onwards, there was very rapid growth in enrolment, partly as a result of the massive admission in 1978 of the huge backlog of young people who had not been able to gain access to higher

education during the period of the Cultural Revolution. This again created a second peak in enrolment in 1981, which was reduced when those admitted in 1978 graduated. This can be seen in the corresponding peak in number of graduates in 1982.

Considering the massive fluctuations during the periods 1957-65 and 1967-76, it is very difficult to establish long term general trends for enrolment, new admissions and graduates. Through the preceding analyses as well as Chart XIII showing the situation for all fields of study, however, a tentative hypothesis can be advanced, by joining together and extending the trends for the periods 1949-57 and 1965-66. This in some sort indicates clearly that total enrolment in 1982-83 has somehow regained the long-term trend level.

In the same way, it can readily be seen that past tendencies in new admissions have also been more or less re-established, if not surpassed in recent years. The trend in graduates is still far from being conspicuous, which will only emerged with more recent data for 1984 and 1985.

A major constraint on the further rapid growth of enrolment is nevertheless appearing on the horizon. The waves of effects of past birth control are beginning to reach higher education, with the gradual reduction in the number of graduates from higher secondary schools, who constitute those eligible for entrance into higher education.

A second factor that calls for precaution in making overly optimistic predictions for the future of the formal higher education system is the increasing role played by non-formal forms of higher education such as the radio and television universities, universities for workers and for peasants, and other organized non-formal higher training for adults. These alternative channels of higher education are foreseen to continue to relieve a part of the demand for higher learning and training. It will be necessary to include them as integral components in the planning of higher education in response to manpower requirements from the industries. In this connection, data on the distribution of students, teaching staff and courses by field of study will have to be systematically collected and analyzed.

Annex

CHART I

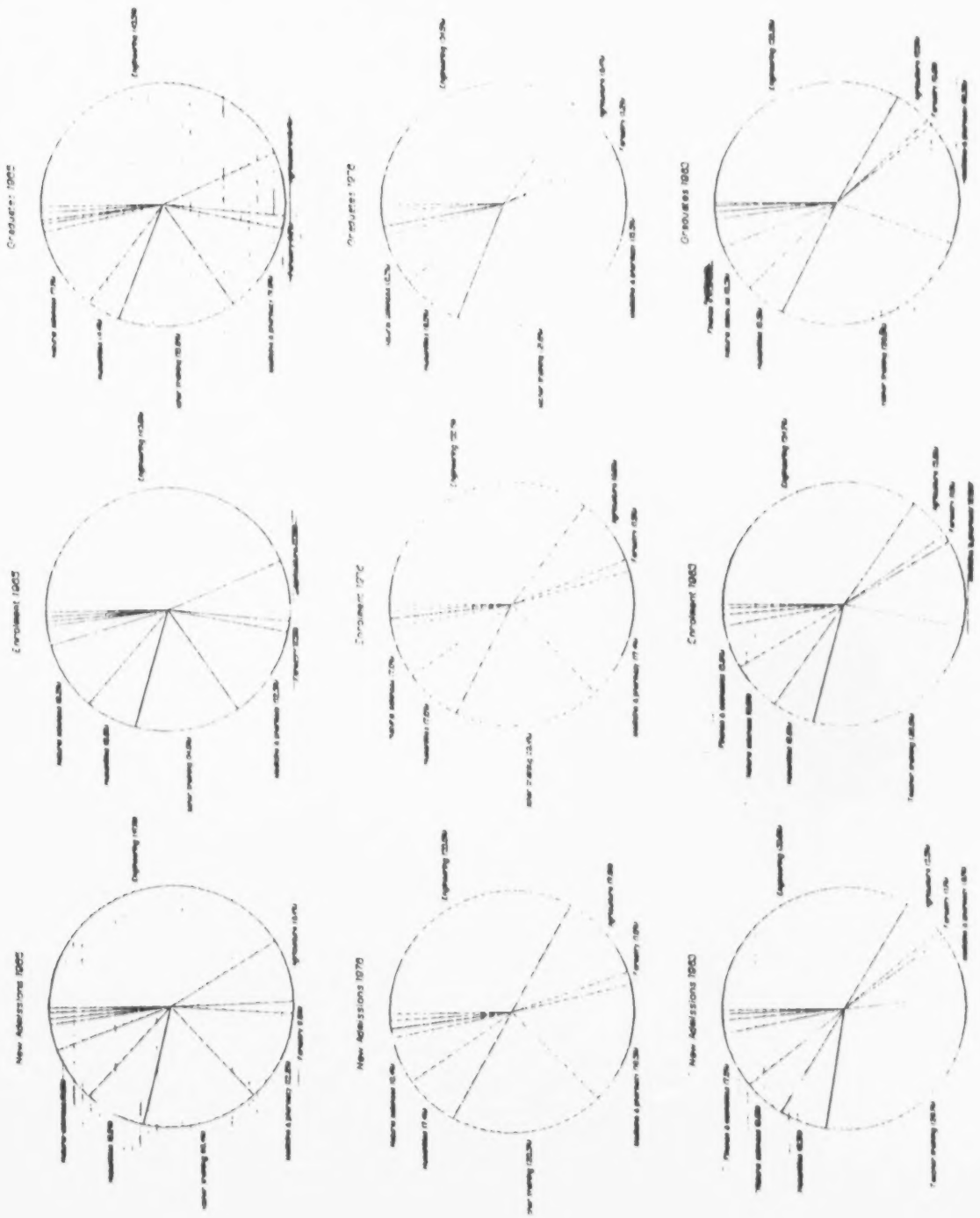


CHART II

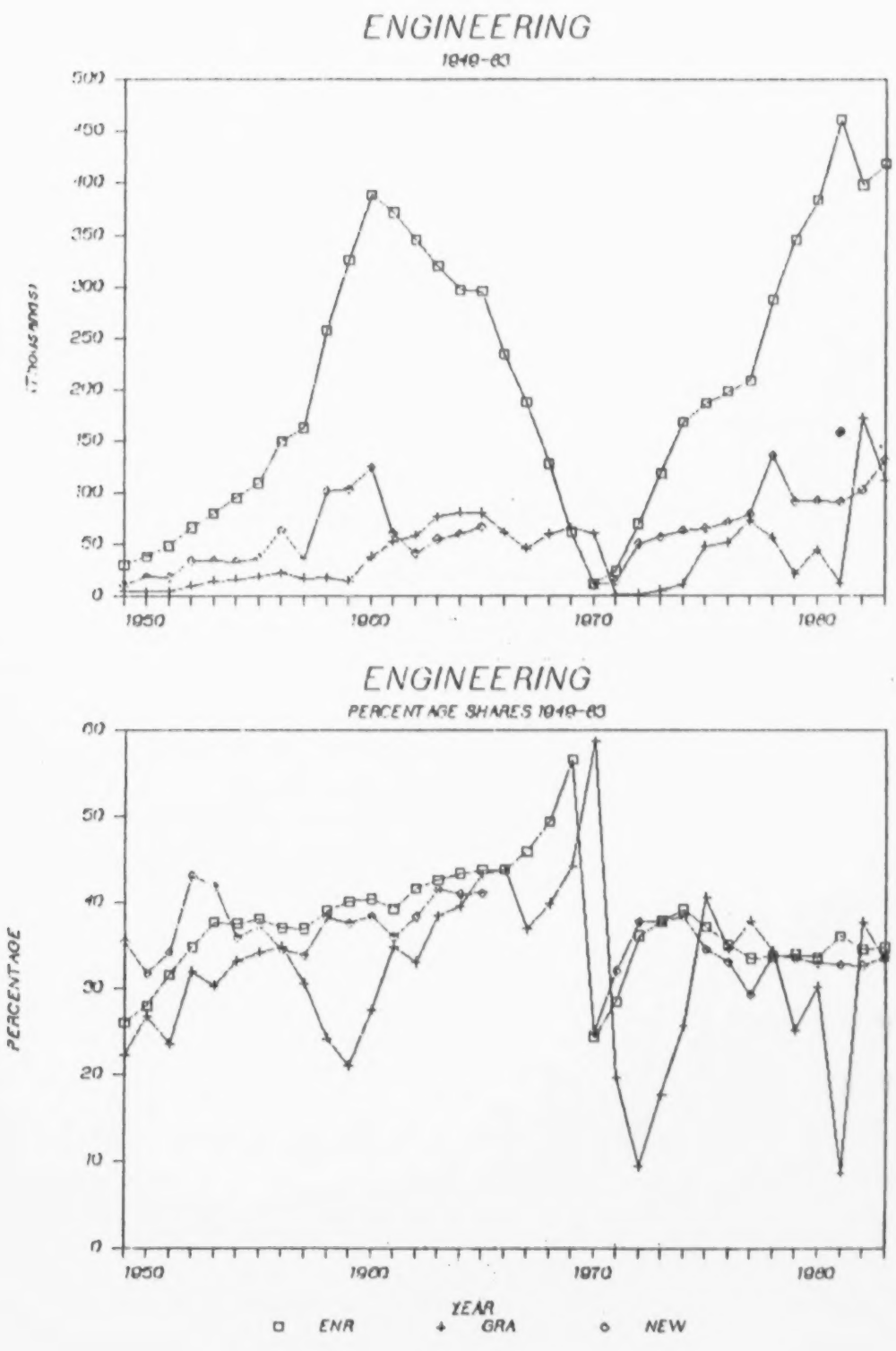

ENGINEERING
1948-83
(THOUSANDS)
500
450
400
350
300
250
200
150
100
50
0
1950
1960
1970
1980
ENGINEERING
PERCENTAGE SHARES 1948-83
PERCENTAGE
60
50
40
30
20
10
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART III

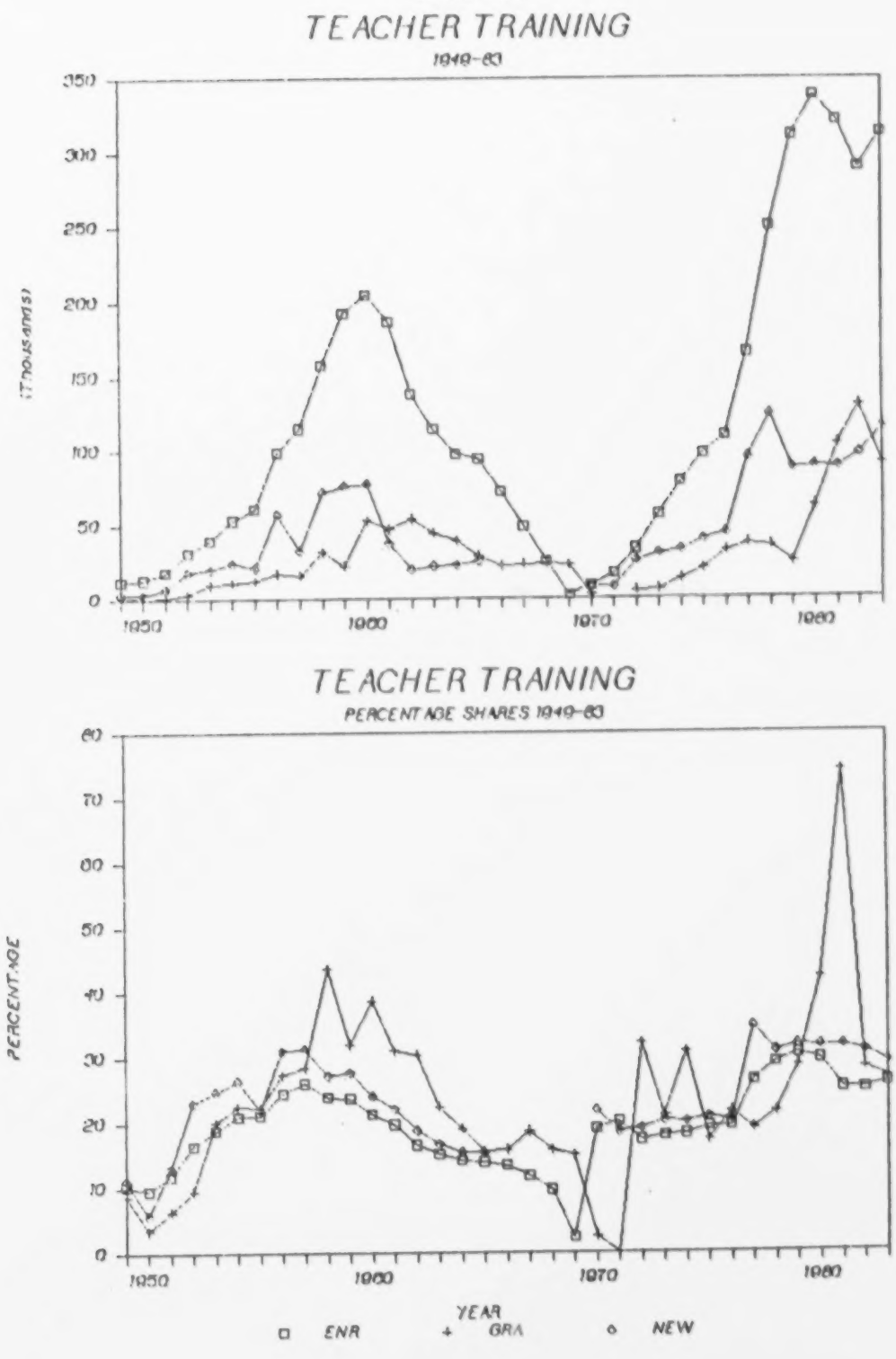
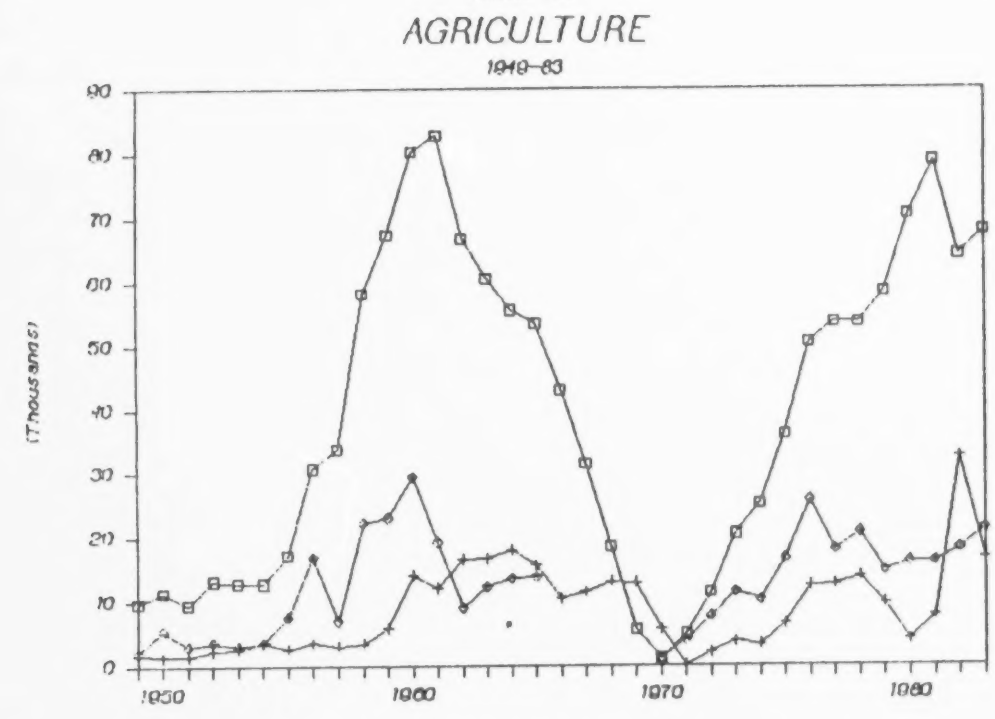

TEACHER TRAINING
1949-80
(THOUSANDS)
350
300
250
200
150
100
50
0
1950
1960
1970
1980
TEACHER TRAINING
PERCENTAGE SHARES 1949-80
PERCENTAGE
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART IV


AGRICULTURE
1948-83
(Thousands)
90
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980

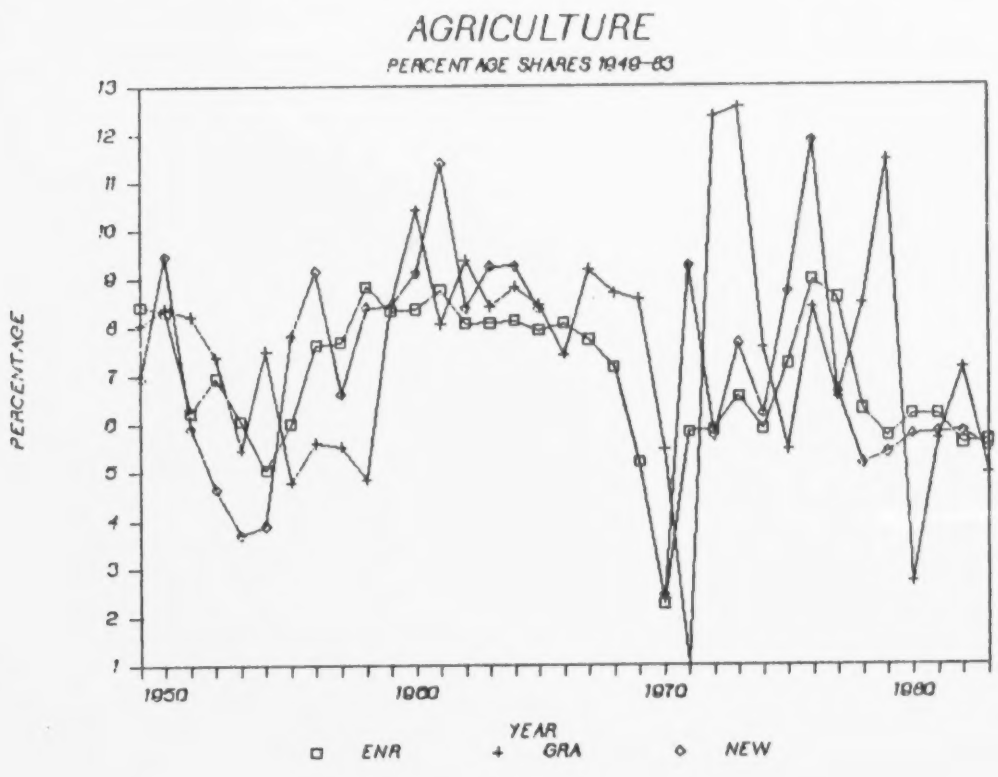

AGRICULTURE
PERCENTAGE SHARES 1948-83
PERCENTAGE
13
12
11
10
9
8
7
6
5
4
3
2
1
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART V

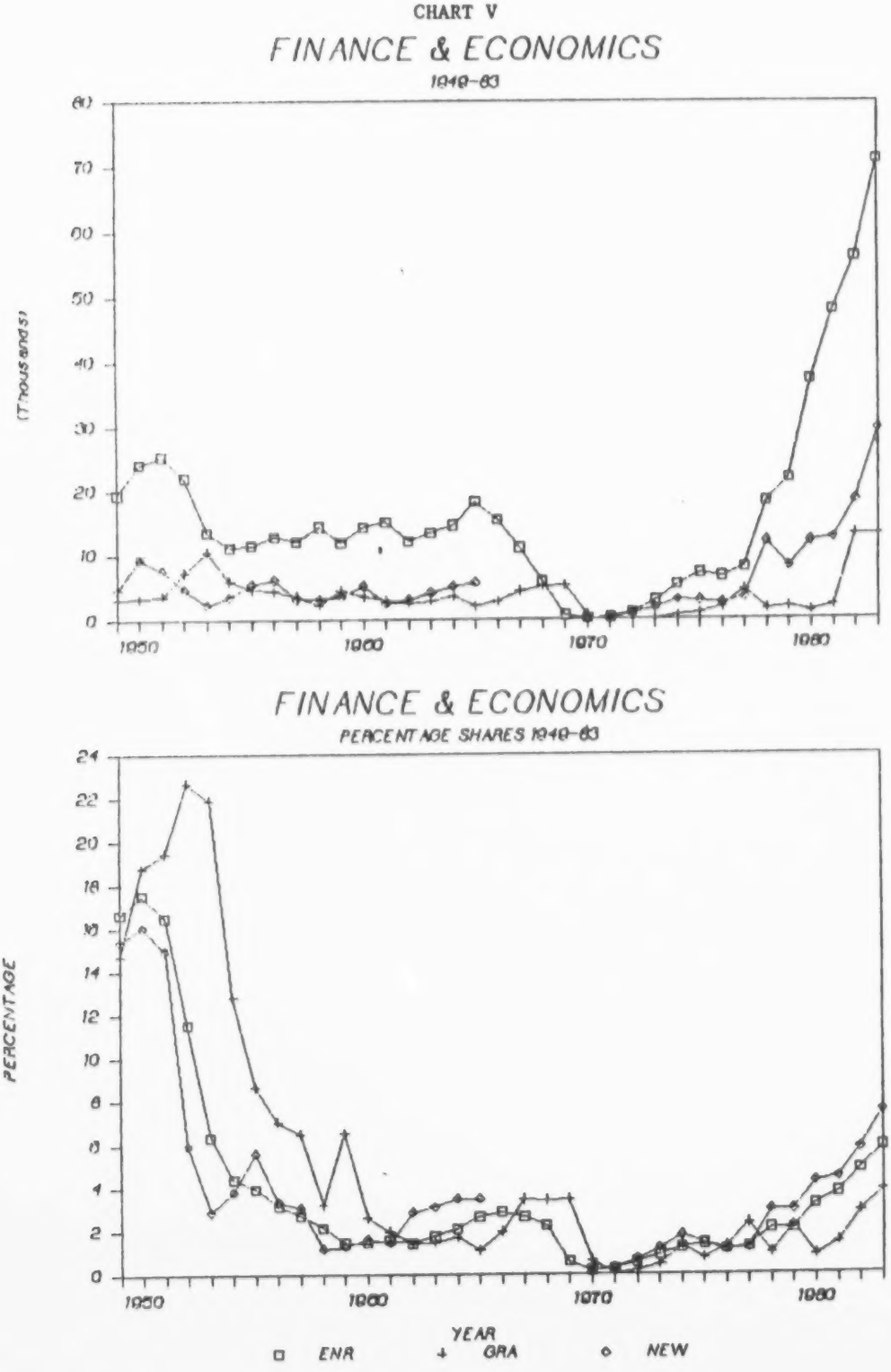
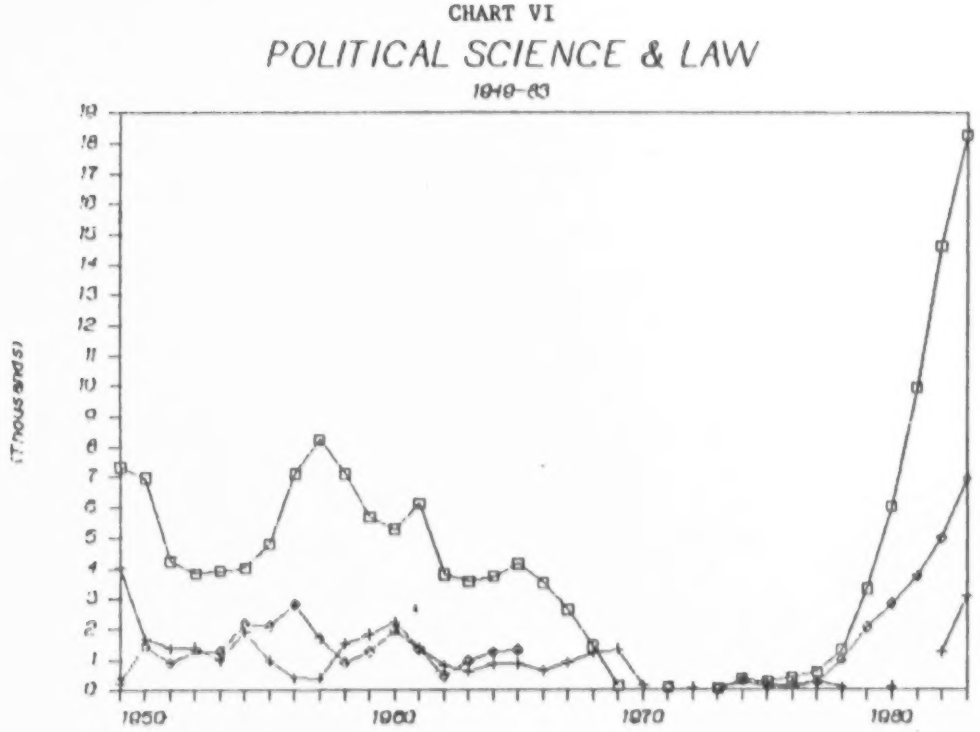

FINANCE & ECONOMICS
1948-83
(THOUSANDS)
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
FINANCE & ECONOMICS
PERCENTAGE SHARES 1948-83
PERCENTAGE
24
22
20
18
16
14
12
10
8
6
4
2
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART VI


POLITICAL SCIENCE & LAW
1948-83
(Thousands)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
1950
1960
1970
1980

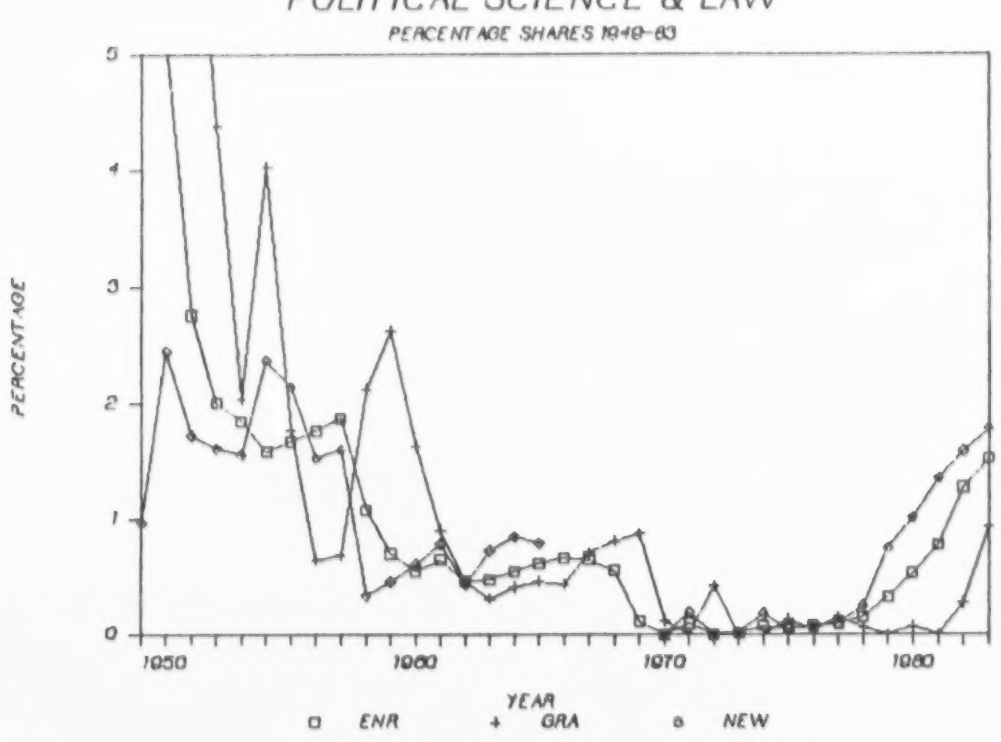

POLITICAL SCIENCE & LAW
PERCENTAGE SHARES 1948-83
PERCENTAGE
0
1
2
3
4
5
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART VII

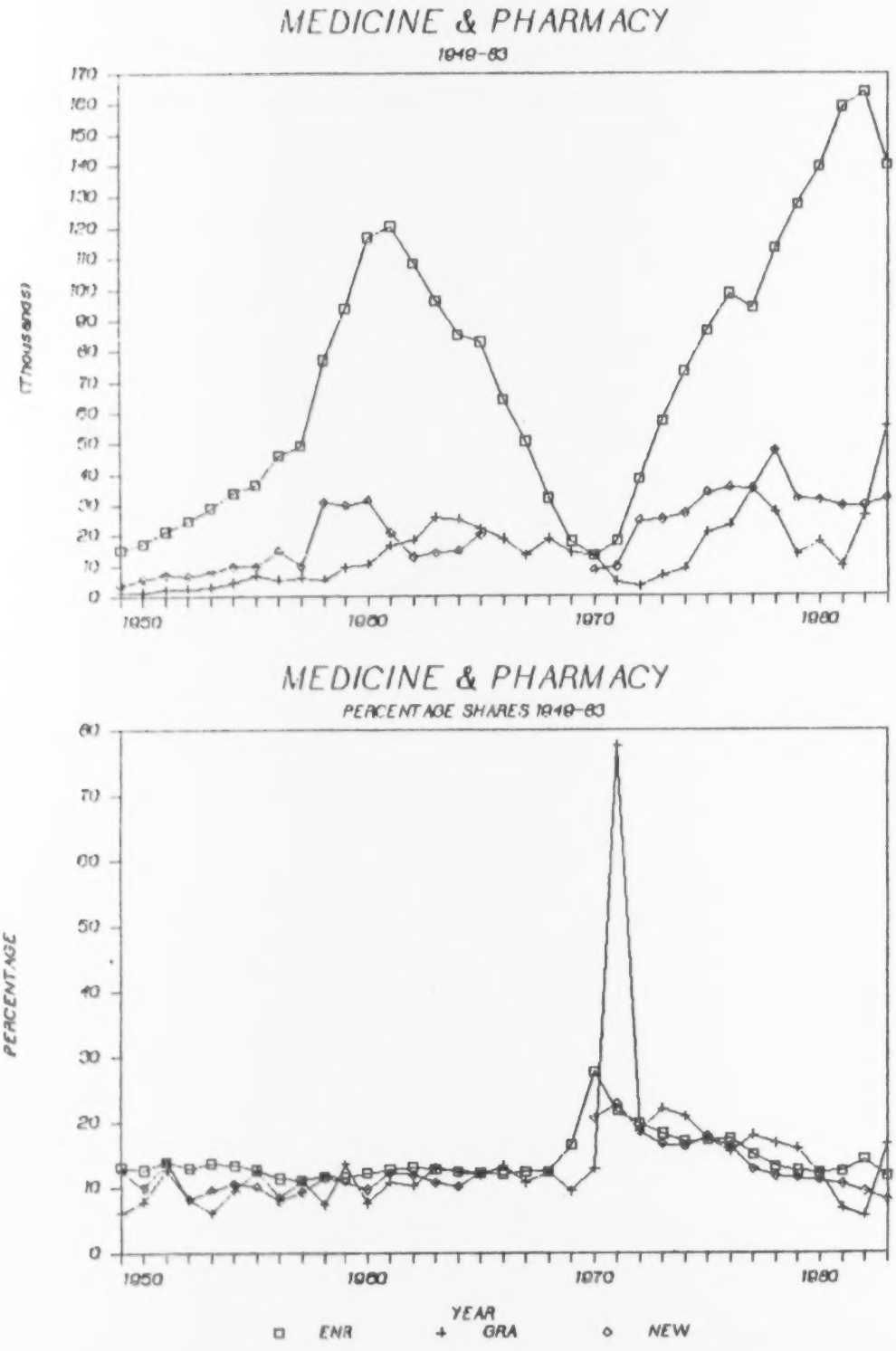

MEDICINE & PHARMACY
1948-83
(Thousands)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
MEDICINE & PHARMACY
PERCENTAGE SHARES 1948-83
PERCENTAGE
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART VIII

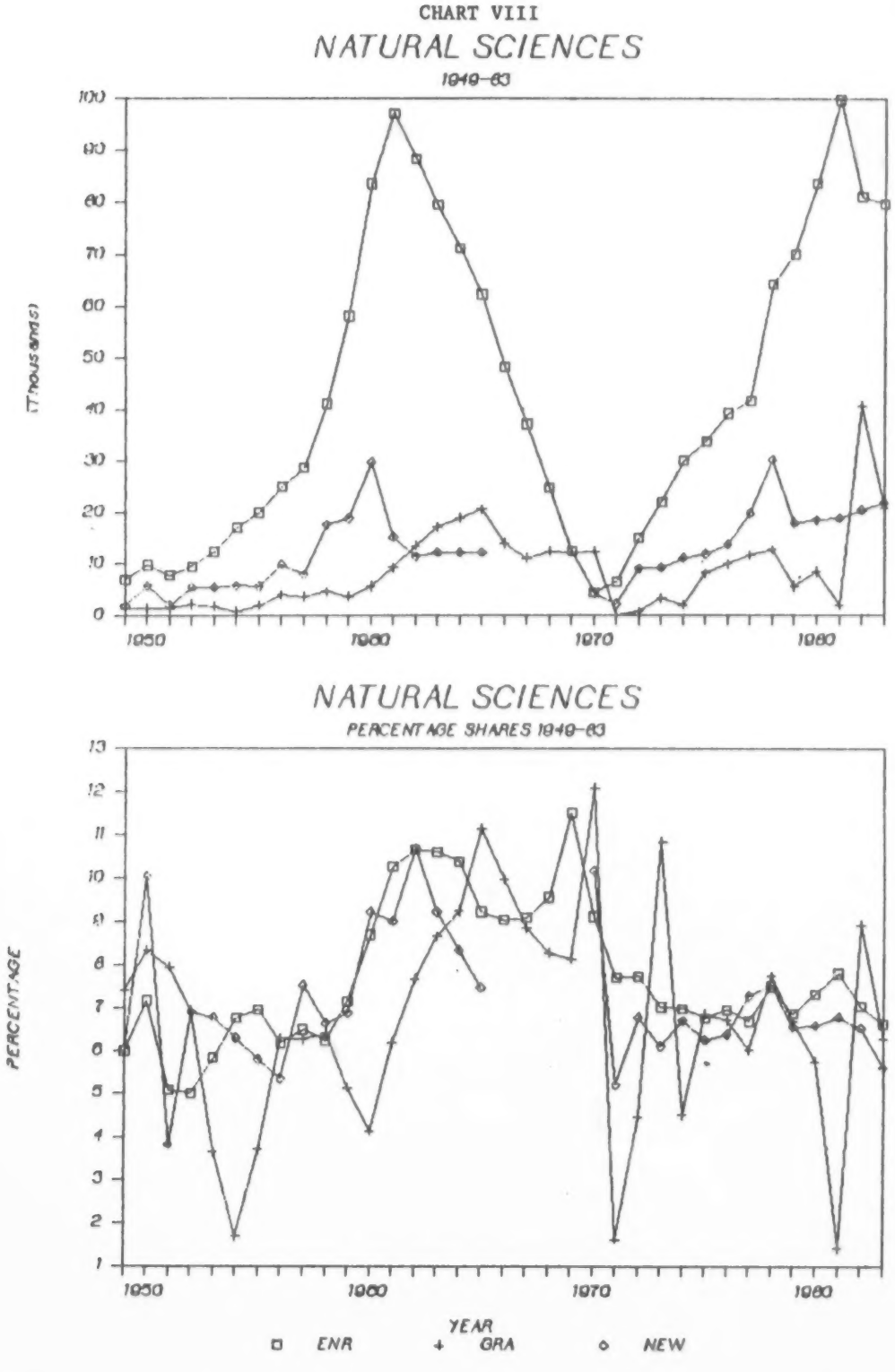

NATURAL SCIENCES
1949-83
(THOUSANDS)
100
90
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980
NATURAL SCIENCES
PERCENTAGE SHARES 1949-83
PERCENTAGE
13
12
11
10
9
8
7
6
5
4
3
2
1
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART IX

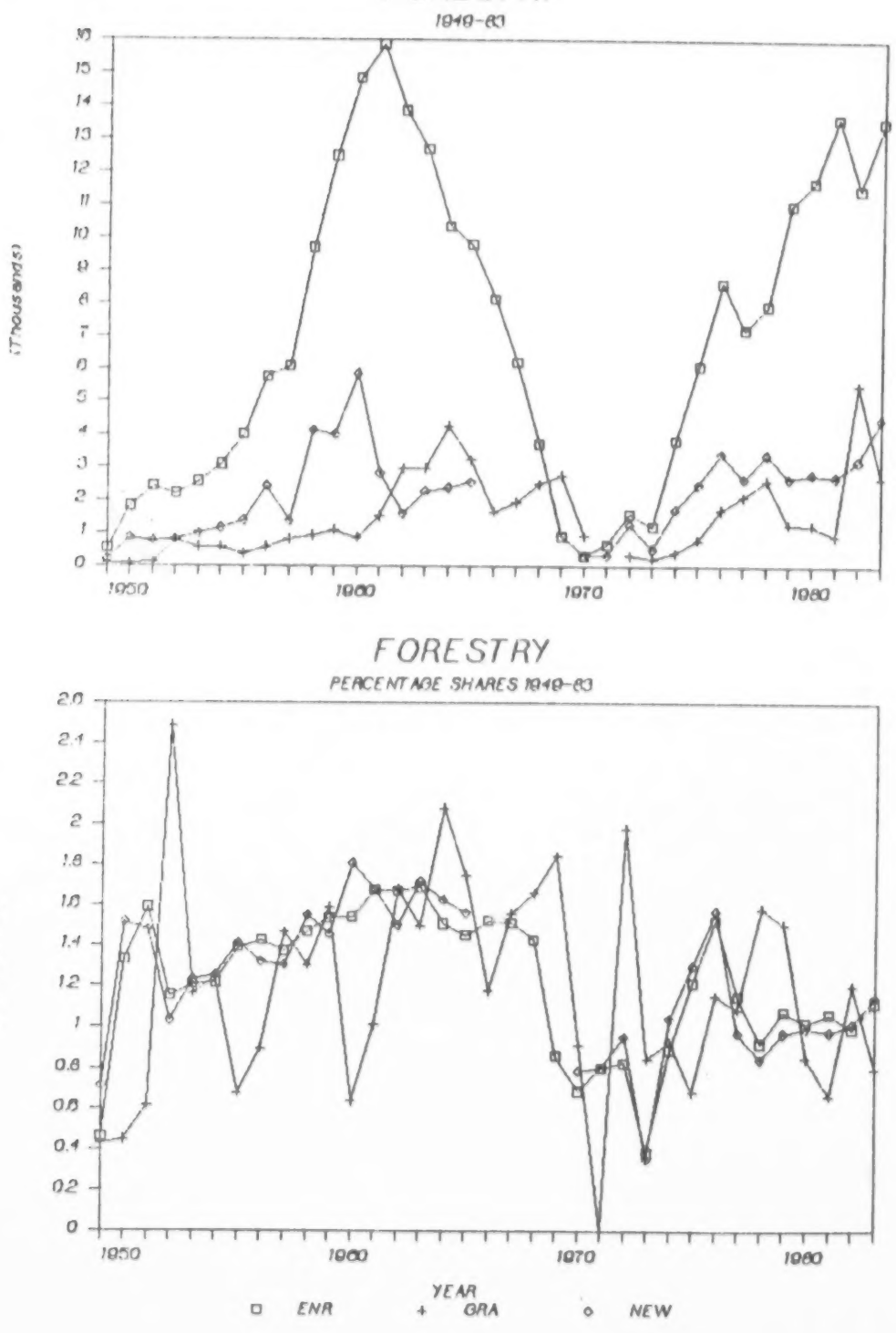

FORESTRY
1948-83
(Thousands)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1950
1960
1970
1980
FORESTRY
PERCENTAGE SHARES 1948-83
PERCENTAGE
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART X

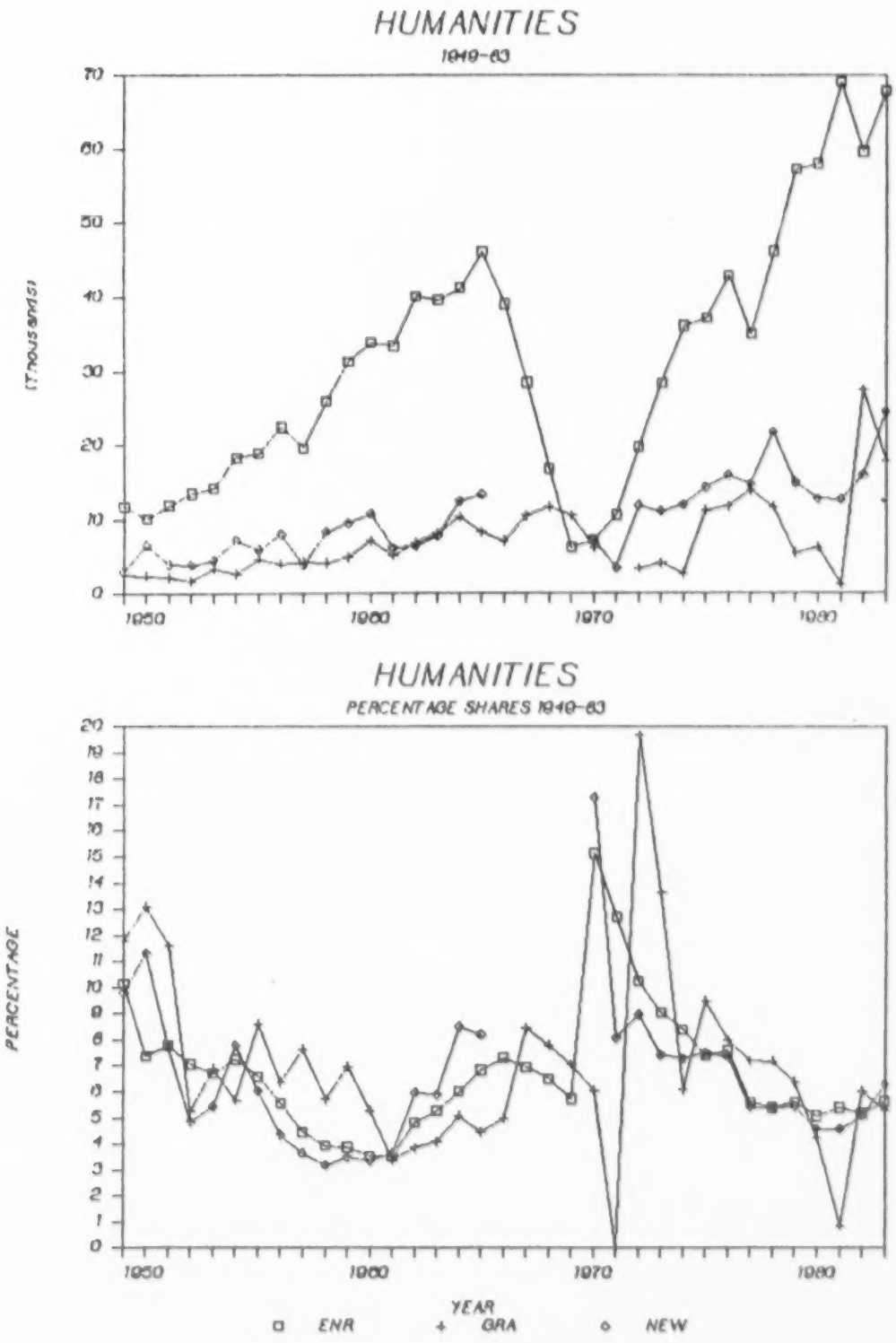

HUMANITIES
1949-83
(THOUSANDS)
70
60
50
40
30
20
10
0
1950
1960
1970
1980
HUMANITIES
PERCENTAGE SHARES 1949-83
PERCENTAGE
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART XI

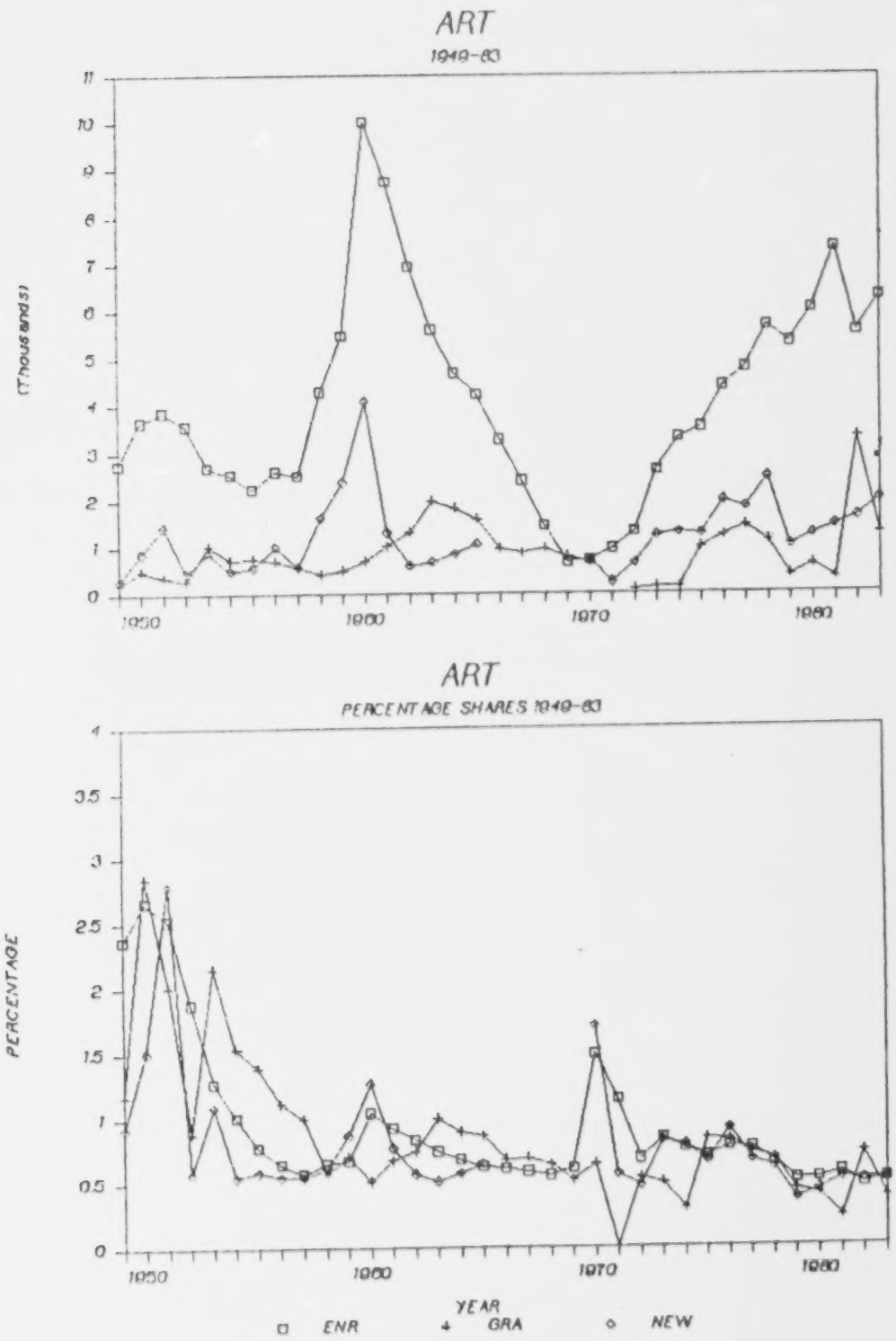
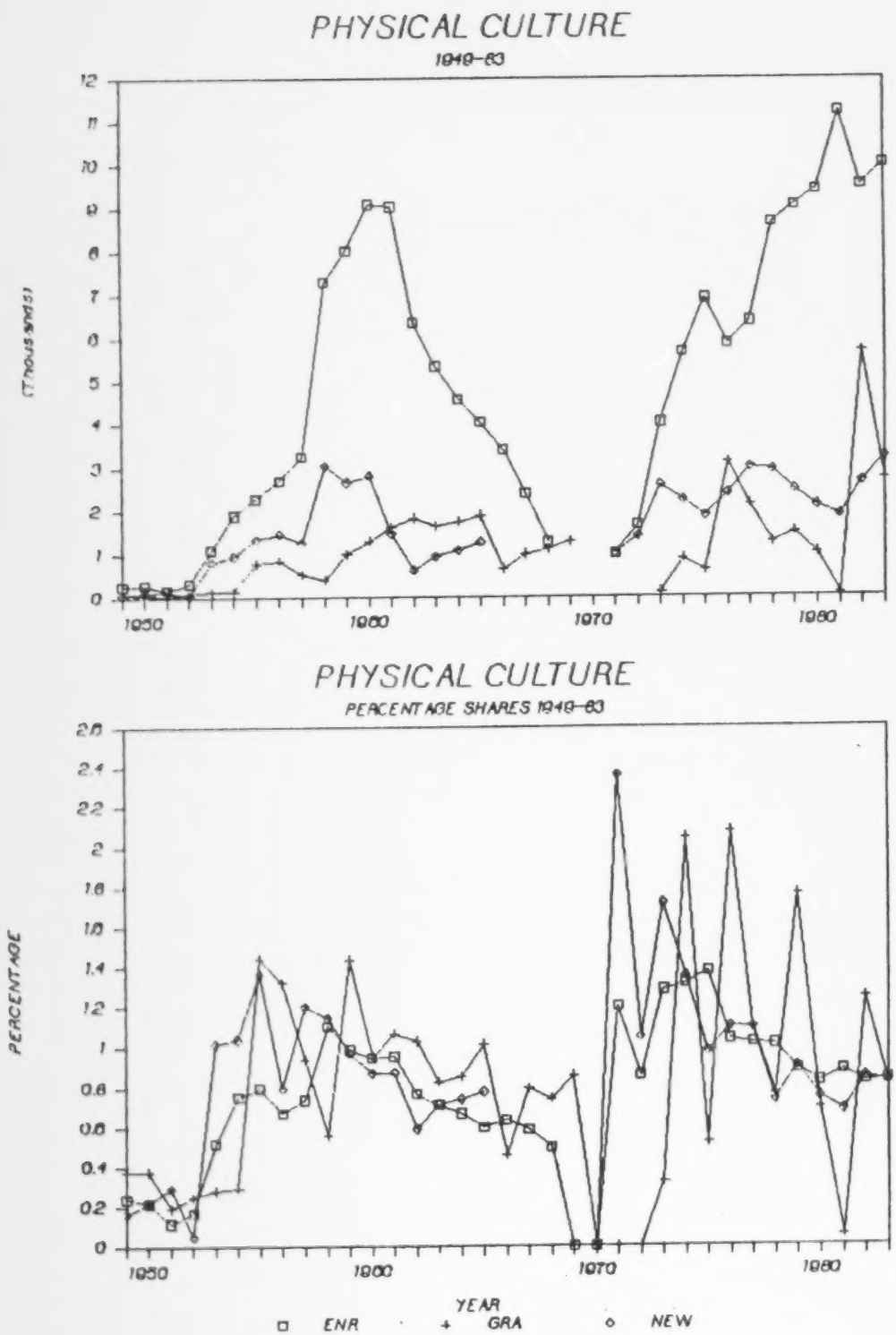

ART
1949-83
(Thousands)
11
10
9
8
7
6
5
4
3
2
1
0
1950
1960
1970
1980
ART
PERCENTAGE SHARES 1949-83
PERCENTAGE
4
3.5
3
2.5
2
1.5
1
0.5
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART XII


PHYSICAL CULTURE
1948-63
(THOUSANDS)
12
11
10
9
8
7
6
5
4
3
2
1
0
1950
1960
1970
1980
PHYSICAL CULTURE
PERCENTAGE SHARES 1948-63
PERCENTAGE
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

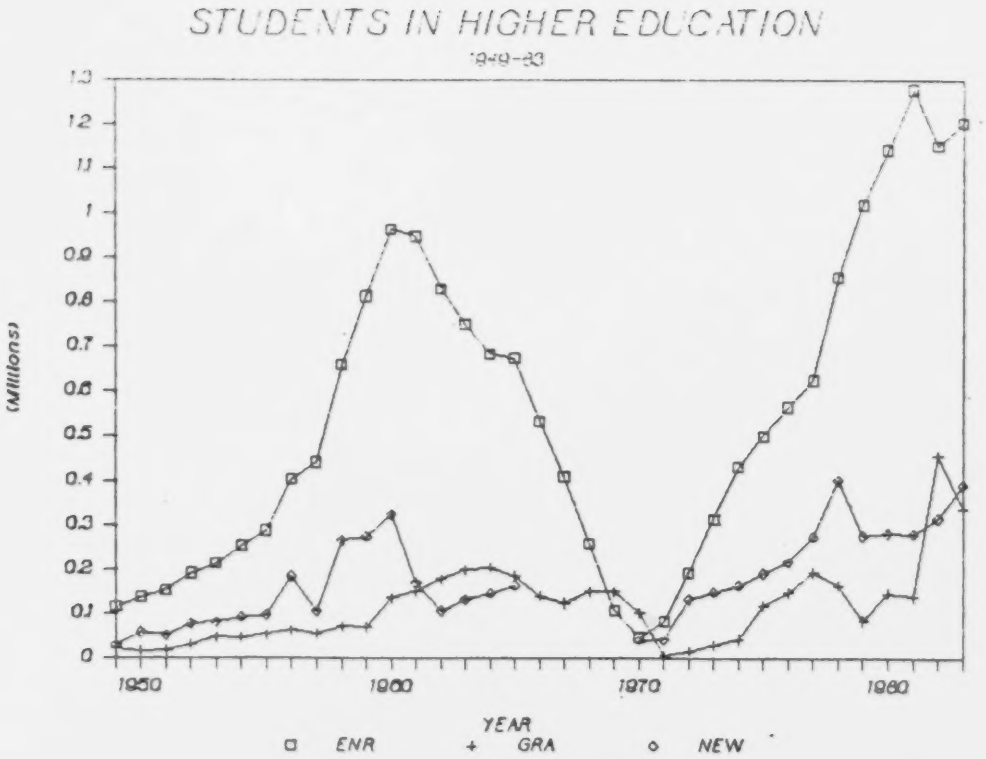

STUDENTS IN HIGHER EDUCATION
1949-83
(Millions)
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1950
1960
1970
1980
YEAR
ENR
GRA
NEW

CHART XIII

学生数 分科
Number of Students by Field of Study

単位: 人

年次 Year	合計 Total	工科 Engineering	農科 Agriculture	林科 Forestry	医薬 Medicine & Pharmacy
1947	154,612	27,555	10,147	-1	11,849
1949	118,504	30,320	9,820	541	15,234
1950	137,470	38,462	11,435	1,833	17,414
1951	153,402	48,517	9,564	2,436	21,358
1952	191,147	66,583	13,262	2,209	24,752
1953	212,181	79,975	12,853	2,567	29,025
1954	252,978	94,991	12,805	3,090	33,919
1955	287,653	109,598	17,264	4,002	36,472
1956	403,178	149,380	30,718	5,755	45,902
1957	461,181	163,026	33,823	6,065	49,107
1958	659,637	257,277	58,192	9,702	77,079
1959	811,947	326,556	67,445	12,484	93,680
1960	961,623	388,769	80,402	14,839	118,925
1961	947,166	371,560	82,932	15,873	120,410
1962	829,699	345,247	66,865	13,862	108,470
1963	750,118	319,524	60,531	12,673	96,140
1964	685,314	296,631	55,603	10,352	85,195
1965	674,636	295,273	53,447	9,793	82,861
1966	533,786	233,750	43,008	8,134	64,129
1967	408,930	187,679	31,552	6,188	50,648
1968	258,736	127,845	18,509	3,897	32,065
1969	108,617	61,480	5,654	935	17,874
1970	67,815	11,623	1,090	330	13,235
1971	83,400	23,700	4,850	670	18,060
1972	193,719	69,918	11,372	1,801	38,340
1973	313,645	118,396	20,514	1,213	57,203
1974	429,881	168,348	25,246	3,824	73,228
1975	500,993	186,298	36,137	6,085	86,338
1976	564,713	198,079	50,529	8,612	98,381
1977	625,319	209,004	53,631	7,194	93,822
1978	858,323	287,648	53,712	7,915	112,990
1979	1018,950	345,430	58,399	10,997	127,400
1980	1143,712	383,520	70,494	11,681	139,569
1981	1279,672	461,265	78,837	13,618	158,988
1982	1153,954	398,214	64,327	11,472	184,038
1983	1206,823	418,545	67,951	13,501	140,061

師範 Teacher Training	文科 Humanities	理科 Natural Sciences	財経 Finance & Economics	政法 Political Science & Law	体育 Physical Culture	芸術 Art
20,818	15,794	9,929	17,698	37,682	594	2,546
12,039	11,829	6,984	19,362	7,338	282	2,755
13,312	10,147	9,845	24,084	6,984	297	3,657
18,225	11,936	7,801	25,300	4,225	180	3,662
31,551	13,511	9,563	21,974	3,830	325	3,587
39,958	14,248	13,382	13,472	3,908	1,098	2,700
53,112	18,346	17,098	11,153	4,017	1,900	2,549
60,657	18,950	19,994	11,395	4,801	2,283	2,237
98,821	22,488	34,930	12,803	7,108	2,699	2,613
114,795	19,643	28,680	12,048	8,245	3,252	2,517
157,278	25,985	41,123	14,322	7,114	7,278	4,297
192,285	31,340	58,106	11,881	5,674	8,023	5,473
204,498	33,905	83,608	14,297	5,271	9,088	10,023
186,841	33,430	97,194	15,028	6,128	9,029	8,745
137,581	40,098	88,433	12,096	3,796	6,334	6,939
114,296	39,648	79,522	13,388	3,571	5,329	5,596
97,462	41,205	71,184	14,540	3,725	4,581	4,676
94,288	46,038	62,232	18,119	4,144	4,026	4,235
72,003	39,017	48,218	15,324	3,527	3,382	3,274
48,778	28,482	37,165	10,992	2,843	2,395	2,410
25,078	16,791	24,728	5,863	1,431	1,282	1,447
2,516	6,217	12,507	847	123	—	664
9,140	7,240	4,357	90	—	—	710
16,840	10,810	6,420	220	80	1,000	950
33,657	19,819	15,002	1,134	—	1,656	1,320
56,365	28,412	22,019	2,836	36	4,018	2,835
78,544	38,111	30,055	5,340	329	5,646	3,312
97,362	37,116	33,888	7,092	269	6,880	3,531
109,731	42,879	29,285	6,569	410	5,843	4,397
165,105	35,038	41,817	7,992	678	8,357	4,783
249,940	46,153	64,170	18,130	1,299	8,643	5,682
311,168	57,244	70,036	21,597	3,315	9,048	5,318
338,197	68,054	83,651	37,082	8,029	9,412	8,023
321,444	69,078	99,840	47,895	9,944	11,241	7,326
289,448	59,883	81,132	55,980	14,635	9,505	6,540
313,339	67,909	79,848	71,100	18,288	10,027	6,266

分科学生数的比重

Percentage Distribution of Students by Field of Study

(%)

年份 Year	合计 Total	工科 Engineering	农科 Agriculture	林科 Forestry	医药 Medicine & Pharmacy	师范 Teacher Training	文科 Humanities	理科 Natural Sciences	财经 Finance & Economics	政法 Political Science & Law	体育 Physical Culture	艺术 Art
1947	100	17.8	6.6	—	7.7	13.5	10.2	6.4	11.4	24.4	0.4	1.6
1949	100	26.0	8.4	0.5	13.1	10.3	10.2	6.0	16.6	6.3	0.2	2.4
1950	100	28.0	8.3	1.3	12.7	9.7	7.4	7.1	17.5	5.1	0.2	2.7
1951	100	31.6	6.2	1.6	13.9	11.9	7.8	5.1	16.5	2.8	0.1	2.5
1952	100	34.8	6.9	1.1	13.0	16.5	7.1	5.0	11.5	2.0	0.2	1.9
1953	100	37.7	6.1	1.2	13.7	18.8	6.7	5.8	6.4	1.8	0.5	1.3
1954	100	37.5	5.1	1.2	13.4	21.0	7.2	6.8	4.4	1.6	0.8	1.0
1955	100	38.1	6.0	1.4	12.7	21.1	6.6	6.9	3.9	1.7	0.8	0.8
1956	100	37.0	7.6	1.4	11.4	24.5	5.6	6.2	3.2	1.8	0.7	0.6
1957	100	37.0	7.7	1.4	11.1	26.0	4.4	6.5	2.7	1.9	0.7	0.6
1958	100	39.0	8.8	1.5	11.7	23.8	3.9	6.2	2.2	1.1	1.1	0.7
1959	100	40.1	8.3	1.5	11.5	23.7	3.9	7.1	1.5	0.7	1.0	0.7
1960	100	40.4	8.4	1.5	12.2	21.3	3.5	8.7	1.5	0.6	0.9	1.0
1961	100	39.2	8.8	1.7	12.7	19.7	3.5	10.3	1.6	0.6	1.0	0.9
1962	100	41.6	8.0	1.7	13.1	16.6	4.8	10.7	1.5	0.5	0.7	0.8
1963	100	42.6	8.1	1.7	12.8	15.2	5.3	10.6	1.8	0.5	0.7	0.7
1964	100	43.3	8.1	1.5	12.4	14.2	6.0	10.4	2.1	0.6	0.7	0.7
1965	100	43.8	7.9	1.5	12.3	14.0	6.8	9.2	2.7	0.6	0.6	0.6
1966	100	43.0	8.3	1.5	12.1	13.8	7.3	9.2	2.9	0.7	0.6	0.6
1967	100	45.9	7.7	1.5	12.4	11.9	7.0	9.1	2.7	0.6	0.6	0.6
1968	100	49.4	7.2	1.4	12.4	9.7	6.5	9.5	2.3	0.5	0.5	0.6
1969	100	56.6	5.2	0.9	16.5	2.3	5.7	11.5	0.6	0.1	—	0.6
1970	100	24.3	2.3	0.7	27.7	19.1	15.1	9.1	0.2	—	—	1.5
1971	100	28.4	5.8	0.8	21.7	20.2	12.7	7.7	0.3	0.1	1.2	1.1
1972	100	36.1	5.9	0.8	19.8	17.3	10.2	7.7	0.6	—	0.9	0.7
1973	100	37.8	6.5	0.4	18.2	18.0	9.1	7.0	0.9		1.3	0.8
1974	100	39.1	5.9	0.9	17.0	18.3	8.4	7.0	1.2	0.1	1.3	0.8
1975	100	37.2	7.2	1.2	17.2	19.4	7.4	6.8	1.4	0.1	1.4	0.7
1976	100	35.1	8.9	1.5	17.4	19.4	7.6	7.0	1.2	0.1	1.0	0.8
1977	100	33.4	8.6	1.1	15.0	26.4	5.6	6.7	1.3	0.1	1.0	0.8
1978	100	33.6	6.3	0.9	13.2	29.2	5.4	7.5	2.1	0.2	1.0	0.6
1979	100	33.9	5.7	1.1	12.5	30.5	5.6	6.9	2.1	0.3	0.9	0.5
1980	100	33.5	6.2	1.0	12.2	29.6	5.1	7.3	3.3	0.5	0.8	0.5
1981	100	36.0	6.2	1.1	12.4	25.1	5.4	7.8	3.7	0.8	0.9	0.6
1982	100	34.3	5.7	1.0	14.3	25.4	5.1	7.0	4.7	1.2	0.8	0.5
1983	100	34.7	5.7	1.1	11.6	26.0	5.6	6.6	5.9	1.5	0.8	0.5

分科招生數

Number of Students Admitted by Field of Study

年份 Year	合計 Total	工科 Engineering	農科 Agriculture	林科 Forestry	醫藥 Medicine & Pharmacy
總計	9570 289	1, 954, 188	397, 315	87, 705	649, 791
1949	30, 573	10, 820	3, 123	218	3, 806
1950	58, 330	18, 521	5, 524	884	5, 781
1951	51, 689	17, 689	3, 049	764	7, 199
1952	70, 865	33, 952	3, 678	816	6, 547
1953	81, 614	34, 185	3, 018	1, 006	7, 794
1954	92, 280	33, 173	3, 604	1, 158	9, 797
1955	97, 797	38, 425	7, 614	1, 380	9, 927
1956	184, 632	83, 750	16, 888	3, 439	14, 894
1957	105, 581	35, 725	6, 985	1, 381	9, 861
1958	265, 553	101, 551	22, 301	4, 117	30, 726
1959	274, 143	103, 051	23, 045	3, 995	29, 812
1960	323, 161	124, 053	29, 425	5, 846	31, 392
1961	169, 047	60, 781	19, 269	2, 835	20, 739
1962	106, 777	40, 928	8, 947	1, 603	12, 709
1963	132, 820	55, 068	12, 265	2, 282	14, 265
1964	147, 037	60, 202	13, 592	2, 390	14, 943
1965	164, 212	67, 444	13, 743	2, 568	20, 044
1970	41, 870	10, 450	1, 030	330	86, 20
1971	42, 420	13, 550	3, 920	340	9, 840
1972	133, 553	50, 395	7, 684	1, 272	24, 692
1973	149, 960	56, 871	11, 459	529	24, 953
1974	165, 084	63, 283	10, 223	1, 722	26, 887
1975	190, 779	65, 870	16, 617	2, 479	33, 785
1976	217, 048	71, 818	25, 728	3, 416	35, 324
1977	272, 971	79, 819	18, 104	2, 682	34, 932
1978	401, 521	135, 741	20, 709	3, 390	47, 320
1979	275, 099	91, 869	14, 797	2, 676	31, 569
1980	281, 230	92, 387	16, 168	3, 803	31, 277
1981	278, 777	91, 261	16, 170	2, 728	29, 241
1982	315, 135	102, 825	18, 313	3, 201	29, 488
1983	390, 800	131, 331	21, 345	4, 477	31, 831

單位: 人

師範 Teacher Training	文科 Humanities	理科 Natural Sciences	財經 Finance & Economics	政法 Political Science & Law	體育 Physical Culture	藝術 Art
1, 425, 915	315, 673	388, 251	186, 857	45, 798	49, 775	38, 168
3, 442	2, 999	1, 841	4, 695	297	81	281
3, 371	8, 589	5, 855	9, 352	1, 425	178	879
6, 838	3, 872	1, 977	7, 726	888	150	1, 439
18, 145	3, 831	5, 433	4, 700	1, 271	40	454
20, 243	4, 438	6, 531	2, 385	1, 271	828	845
24, 374	7, 188	5, 815	3, 528	2, 180	960	503
21, 413	5, 899	5, 670	5, 479	2, 087	1, 332	571
57, 274	8, 006	9, 877	6, 207	2, 824	1, 465	1, 008
33, 065	3, 844	7, 944	3, 240	1, 891	1, 268	577
72, 034	8, 433	17, 843	3, 181	898	3, 034	1, 635
75, 927	9, 842	18, 857	3, 632	1, 248	2, 656	2, 378
77, 710	10, 776	29, 813	5, 272	1, 964	2, 806	4, 104
37, 409	6, 165	15, 219	2, 518	1, 320	1, 476	1, 308
20, 041	6, 358	11, 414	3, 084	480	827	606
23, 138	7, 837	12, 251	4, 128	959	949	680
22, 849	12, 506	12, 260	5, 120	1, 243	1, 015	847
25, 329	13, 461	12, 266	5, 726	1, 298	1, 272	1, 063
9, 140	7, 240	4, 260	90	—	—	710
7, 890	3, 420	2, 210	130	80	1, 000	240
25, 552	11, 974	9, 058	914	—	1, 398	634
30, 418	11, 132	9, 154	1, 802	36	2, 572	1, 234
33, 108	12, 016	11, 077	2, 954	293	3, 227	1, 296
39, 712	14, 335	11, 922	2, 834	100	1, 858	1, 267
44, 167	15 981	13, 846	2, 453	179	3, 343	1, 973
94, 586	14, 781	19, 838	3, 389	256	2, 977	1, 827
123, 996	21, 765	30, 261	11, 960	995	2, 926	2, 458
87, 481	14, 984	18, 053	8, 143	2, 041	2, 470	1, 016
89, 046	12, 863	18, 539	11, 973	2, 838	2, 095	1, 241
88, 207	12, 763	18, 914	12, 405	3, 751	1, 889	1, 448
97, 177	16, 048	20, 573	18, 274	4, 982	2, 646	1, 610
113, 889	24, 537	21, 880	29, 385	6, 923	3, 206	1, 996

分科招生数的比重

Percentage Distribution of Students Admitted by Field of Study

(%)

年份 Year	合计 Total	工科 Engineering	农科 Agriculture	林科 Forestry	医药 Medicine & Pharmacy	师范 Teacher Training	文科 Humanities	理科 Natural Sciences	财经 Finance & Economics	政法 Political Science & Law	体育 Physical Culture	艺术 Art
1949	100	35.4	6.9	0.7	12.4	11.3	9.8	6.0	15.4	1.0	0.2	0.9
1950	100	31.8	9.5	1.5	9.9	5.8	11.3	10.0	16.0	2.5	0.2	1.5
1951	100	34.2	5.9	1.5	13.9	13.2	7.7	3.8	15.0	1.7	0.3	2.8
1952	100	43.0	4.7	1.0	8.3	23.0	4.9	6.9	6.0	1.6	—	0.6
1953	100	42.0	3.7	1.2	9.6	24.8	5.4	6.8	2.9	1.6	1.0	1.0
1954	100	36.0	3.9	1.3	10.6	26.4	7.8	6.3	3.8	2.4	1.0	0.5
1955	100	37.3	7.8	1.4	10.1	21.9	6.0	5.8	5.6	2.1	1.4	0.6
1956	100	34.5	9.2	1.3	8.1	31.0	4.3	5.4	3.4	1.5	0.8	0.5
1957	100	33.9	6.6	1.3	9.3	31.3	3.6	7.5	3.1	1.6	1.2	0.6
1958	100	38.3	8.4	1.6	11.6	27.1	3.2	6.6	1.2	0.3	1.1	0.6
1959	100	37.6	8.4	1.4	10.9	27.7	3.5	6.9	1.3	0.5	1.0	0.8
1960	100	38.4	9.1	1.8	9.7	24.1	3.3	9.2	1.6	0.6	0.9	1.3
1961	100	35.9	11.4	1.7	12.3	22.1	3.6	9.0	1.5	0.8	0.9	0.8
1962	100	38.3	8.4	1.5	11.9	18.8	5.9	10.7	3.0	0.4	0.6	0.5
1963	100	41.5	9.2	1.7	10.8	16.7	5.9	9.2	3.1	0.7	0.7	0.5
1964	100	40.9	9.3	1.6	10.2	15.5	8.5	8.3	3.5	0.9	0.7	0.6
1965	100	41.1	8.4	1.5	12.2	15.4	8.2	7.5	3.5	0.8	0.8	0.6
1970	100	25.0	2.4	0.8	20.6	21.8	17.3	10.2	0.2	—	—	1.7
1971	100	31.9	9.2	0.8	22.7	18.6	8.1	5.2	0.3	0.2	2.4	0.6
1972	100	37.7	5.7	0.9	18.5	19.1	9.0	6.8	0.7	—	1.1	0.5
1973	100	37.8	7.6	0.4	16.7	20.3	7.4	6.1	1.2	—	1.7	0.8
1974	100	38.3	6.2	1.0	16.3	20.1	7.3	6.7	1.8	0.2	1.3	0.8
1975	100	34.5	8.7	1.3	17.7	20.8	7.5	6.2	1.5	0.1	1.0	0.7
1976	100	33.0	11.9	1.6	16.3	20.3	7.3	6.4	1.1	0.1	1.1	0.9
1977	100	29.2	6.6	1.0	12.8	34.6	5.4	7.3	1.2	0.1	1.1	0.7
1978	100	33.8	5.2	0.8	11.8	30.9	5.4	7.5	3.0	0.3	0.7	0.6
1979	100	33.4	5.4	1.0	11.5	31.8	5.4	6.6	2.9	0.7	0.9	0.4
1980	100	32.9	5.7	1.0	11.1	31.7	4.6	6.6	4.3	1.0	0.7	0.4
1981	100	32.7	5.8	1.0	10.5	31.6	4.6	6.8	4.5	1.3	0.7	0.5
1982	100	32.6	5.8	1.0	9.4	30.9	5.1	6.5	5.8	1.6	0.8	0.5
1983	100	33.6	5.5	1.2	8.1	29.1	6.3	5.6	7.5	1.8	0.8	0.5

分科毕业生数

Number of Graduates by Field of Study

单位：人

年份 Year	合计 Total	工科 Engineering	农科 Agriculture	林科 Forestry	医药 Medicine & Pharmacy
总计	4,110,207	1,435,012	304,330	81,555	496,632
1949	21,353	4,752	1,718	92	1,314
1950	17,607	4,711	1,477	79	1,391
1951	18,712	4,418	1,538	116	2,368
1952	31,002	10,213	2,361	796	2,636
1953	48,091	14,565	2,633	582	3,948
1954	47,069	15,596	3,532	587	4,527
1955	54,466	18,614	2,614	370	6,840
1956	63,214	22,047	3,641	567	5,403
1957	56,180	17,162	3,104	824	6,200
1958	72,424	17,499	3,513	946	6,393
1959	69,839	14,714	5,877	1,109	9,456
1960	136,138	37,430	14,164	870	10,470
1961	151,283	52,714	12,179	1,534	16,481
1962	177,255	58,573	16,588	2,974	18,335
1963	198,756	76,359	16,721	2,980	25,776
1964	204,499	80,917	18,020	4,251	25,079
1965	183,521	80,294	15,665	3,237	22,027
1966	140,670	61,523	10,439	1,659	18,732
1967	124,836	46,071	11,456	1,946	13,481
1968	150,194	59,834	13,043	2,491	18,583
1969	130,119	66,365	12,855	2,762	14,191
1970	102,672	60,307	6,594	935	13,259
1971	9,945	1,173	80	—	4,815
1972	18,961	1,615	2,097	335	3,182
1973	30,057	5,316	3,772	255	6,618
1974	43,282	11,104	3,270	402	8,992
1975	118,955	48,240	6,490	810	20,760
1976	149,154	51,448	12,492	1,717	23,154
1977	194,426	73,562	12,706	2,119	34,860
1978	164,581	68,512	13,929	2,605	27,459
1979	85,085	21,382	9,748	1,281	13,483
1980	148,635	44,184	4,009	1,219	17,856
1981	139,640	12,199	7,902	933	9,513
1982	457,244	172,238	32,562	5,488	25,963
1983	335,344	111,405	16,661	2,674	55,490

师范 Teacher Training	文科 Humanities	理科 Natural Sciences	财经 Finance & Economics	政法 Political Science & Law	体育 Physical Culture	艺术 Art
1,945,881	265,775	301,078	130,632	32,415	37,113	29,784
1,890	2,521	1,584	3,137	4,015	80	250
624	2,306	1,468	3,305	1,679	66	501
1,206	2,169	1,488	3,636	1,363	36	376
3,077	1,676	2,215	7,263	1,403	79	283
9,650	3,306	1,753	10,530	977	134	1,033
10,551	2,863	802	6,033	1,897	138	723
12,133	4,679	2,015	4,699	962	783	757
17,213	4,025	3,978	4,460	409	836	706
15,948	4,294	3,524	3,851	385	526	562
31,595	4,131	4,645	2,349	1,531	402	420
22,352	4,870	3,548	4,548	1,826	1,002	497
52,636	7,174	5,626	3,559	2,217	1,295	697
46,018	5,118	9,351	2,988	1,368	1,812	1,024
53,832	6,830	13,603	2,575	802	1,820	1,323
44,452	8,101	17,193	2,942	813	1,638	1,979
38,958	10,413	16,919	3,535	836	1,742	1,829
28,966	8,252	20,668	2,079	857	1,876	1,600
22,265	7,021	14,014	2,795	617	844	961
23,227	10,535	11,053	4,332	884	987	884
23,698	11,691	12,437	5,129	1,212	1,113	963
22,562	10,574	12,221	5,216	1,308	1,282	783
9,516	6,217	12,410	617	123	—	644
—	—	97	—	—	—	—
8,447	3,336	758	29	71	—	91
8,349	4,101	3,256	145	—	96	149
13,344	2,633	1,954	571	—	884	128
20,516	11,298	8,167	905	160	618	991
32,153	11,891	10,008	1,922	48	3,089	1,231
37,038	13,992	11,693	4,589	294	2,135	1,438
35,430	11,808	12,743	1,627	99	1,256	1,113
24,331	5,421	5,682	1,904	—	1,498	375
61,942	6,213	8,421	1,268	109	1,010	594
103,422	1,210	1,989	2,079	—	73	321
129,463	27,449	40,747	13,143	1,238	5,647	3,308
90,147	17,839	21,008	13,040	3,113	2,718	1,251

分科毕业生数的比重

Percentage Distribution of Graduates by Field of Study

(%)

年份 Year	合计 Total	工科 Engineering	农科 Agriculture	林科 Forestry	医药 Medicine & Phamacy	师范 Teacher Training	文科 Humanities	理科 Natural Sciences	财经 Finance & Economics	政法 Political Science & Law	体育 Physical Culture	艺术 Art
总计 Total	100	34.9	7.4	1.3	12.1	25.4	6.0	7.3	3.2	0.8	0.9	0.7
1949	100	22.2	8.0	0.4	6.2	8.9	11.8	7.4	14.7	18.8	0.4	1.2
1950	100	26.8	8.4	0.4	7.9	3.5	13.1	8.3	18.8	9.5	0.4	2.9
1951	100	23.6	8.2	0.6	12.7	6.5	11.6	7.9	19.4	7.3	0.2	2.0
1952	100	31.9	7.4	2.5	8.2	9.6	5.2	6.9	22.7	4.4	0.3	0.9
1953	100	30.3	5.5	1.2	6.1	20.1	6.9	3.6	21.9	2.0	0.3	2.1
1954	100	33.1	7.5	1.3	9.6	22.4	5.7	1.7	12.8	4.0	0.3	1.6
1955	100	34.2	4.8	0.7	12.5	22.3	8.6	3.7	8.6	1.8	1.4	1.4
1956	100	34.9	5.6	0.9	8.6	27.3	6.4	6.3	7.0	0.6	1.3	1.1
1957	100	30.6	5.5	1.5	11.0	28.4	7.6	6.3	6.5	0.7	0.9	1.0
1958	100	24.2	4.8	1.3	7.5	43.6	5.7	6.4	3.2	2.1	0.6	0.6
1959	100	21.1	8.4	1.6	13.5	32.0	7.0	5.2	6.5	2.6	1.4	0.7
1960	100	27.5	10.4	0.6	7.7	38.7	5.3	4.1	2.6	1.6	1.0	0.5
1961	100	34.2	8.0	1.0	10.9	31.0	3.4	6.2	2.0	0.9	1.1	0.7
1962	100	33.0	9.4	1.7	10.3	30.4	3.9	7.7	1.4	0.5	1.0	0.7
1963	100	38.4	8.4	1.5	13.0	22.4	4.1	8.6	1.5	0.3	0.8	1.0
1964	100	39.6	8.8	2.1	12.3	19.0	5.1	9.2	1.7	0.4	0.9	0.9
1965	100	43.3	8.4	1.7	11.9	15.6	4.5	11.1	1.1	0.5	1.0	0.9
1966	100	43.7	7.4	1.2	13.3	15.8	5.0	10.0	2.0	0.4	0.5	0.7
1967	100	36.9	9.2	1.5	10.8	18.6	8.4	8.9	3.5	0.7	0.8	0.7
1968	100	39.8	8.7	1.7	12.4	15.8	7.8	8.3	3.4	0.8	0.7	0.6
1969	100	44.2	8.6	1.8	9.5	15.0	7.0	8.1	3.5	0.9	0.9	0.5
1970	100	58.7	5.5	0.9	12.9	2.5	6.1	12.1	0.6	0.1	—	0.6
1971	100	19.7	1.0	—	77.6	—	—	1.7	—	—	—	—
1972	100	9.5	12.4	2.0	18.7	32.1	19.7	4.5	0.2	0.4	—	0.5
1973	100	17.7	12.6	0.9	22.0	21.1	13.6	10.8	0.5	—	0.3	0.5
1974	100	25.7	7.5	0.9	20.8	30.9	6.1	4.5	1.3	—	2.0	0.3
1975	100	40.6	5.5	0.7	17.4	17.2	9.5	6.9	0.8	0.1	0.5	0.8
1976	100	34.5	8.4	1.1	15.5	21.6	8.0	6.7	1.3	—	2.1	0.8
1977	100	37.8	6.5	1.1	17.9	19.1	7.2	6.0	2.4	0.2	1.1	0.7
1978	100	34.3	8.4	1.6	16.7	21.5	7.2	7.7	1.0	0.1	0.8	0.7
1979	100	25.1	11.5	1.5	15.8	28.6	6.4	6.7	2.2	—	1.8	0.4
1980	100	30.1	2.7	0.9	12.1	42.2	4.2	5.7	0.9	0.1	0.7	0.4
1981	100	8.7	5.7	0.7	6.8	74.1	0.9	1.4	1.5	—	—	0.2
1982	100	37.7	7.1	1.2	5.7	28.3	6.0	8.9	2.9	0.3	1.2	0.7
1983	100	33.2	5.0	0.8	16.5	26.9	5.3	6.3	3.9	0.9	0.8	0.4

Lecture 8

Process and actors in higher education planning

by S. Lourié

Planning of higher education

1. It may be worthwhile to recall that educational planning can be viewed as a process leading to a 'product' which may be a Plan, a Programme, a Yearly Budget or a specific action. Its 'actors' are not be limited to those who actually write up the final version of the 'product' but must include all those who are to be involved—from beginning to end—in the identification of the issues, in their analysis, in the remedies proposed, in the selection of the proper solution and in the design, conduct and monitoring of its implementation. Thus, the 'locus' of these actors cannot be circumscribed to a single identifiable administrative unit (i.e. Planning Bureau) which has a responsibility for organizing and dynamising the Process but not of actually running all its parts. It is diffused throughout all the actors' structures.

2. The four key-stages of the Process are: 1. Monitoring past action, information and data collection on the functioning of the system; 2. Data analysis and dissemination: synthesis of emerging or key issues; 3. Participation in policy choices: consideration of alternatives; 4. Designing and organizing a strategy for implementation of policy decisions.

These four stages or types of responsibilities do not always involve one single group of actors such as those responsible for the planning unit or Department or Bureau. Often their role is limited to parts of 1 (Information and data collection) and of 2 (Data analysis and dissemination) and of 4 (Design of strategy) and not necessarily to the rest of these stages (Monitoring in 1; Synthesis in 2 and Organization of strategy in 4) or to stage 3 (Participation in policy choices). Other actors: top echelon of the Government or of the Ministry of Education, Heads of Universities, Heads of Departments of Education in the Central or Provincial Ministries, etc., play a key role, particularly in policy matters (stage 3) and in control of implementation (stages 1 and 4), etc...

3. Thus, looking more specifically at Higher Education Planning, we note that for:

- *Stage 1*: All actors must possess information concerning the functioning of the system (student flows, outcomes and costs; structure and functions of institutions and specifically of all their human, material and financial inputs) but also concerning the institutions and processes which link it to the external context (national, provincial, local) within which the institutions operate: social demand, employment demands, science and technology's development migration, etc. Most information will be yielded by proper monitoring of stage 4 (see below).

- *Stage 2*: This information must be processed and give rise to the identification of issues (opening of new institutions or programmes; modification of existing programmes; solutions to financing modes; linkages between Governmental and non-governmental demands; forecast of future impact of demography, migration; anticipation of likely changes in attitudes on the part of students, of employers, etc.).

- *Stage 3*: The existence of such alternative solutions to emerging or key (priority) problems must be debated by decision makers who will weigh overall ideological or political orientations viewed on a more global scale (nation wide, province wide or city wide) against the technically justified proposals—or alternatives—flowing from stage 2. The alternative proposals should be elaborated by all the key actors likely to be involved in their future implementation.

- *Stage 4*: Once the decision has been taken (ideally, but not always in dialogue with planners directly involved in the previous stages), then this must be translated into operational terms (*who* does what? by what *time*? following *which* indicators?). This is the key. stage: that of implementation Planners are not likely to be responsible for its full accomplishment but are expected to draw up the blue-prints for those who will actually carry out the functions corresponding to the decision taken. This is the strategy which they need to contribute to as no plan—no matter how well prepared—can be translated into action without constant re-adjustments and adaptations due to (a) the differences among the actual operational conditions of the units of the system; (b) unexpected modifications in input provisions or output flows.

4. The 'actors' who are likely to be involved as well as the process itself cannot be defined hierarchically. Ministers as well as teachers and students are involved. Naturally, the radius of their influence varies considerably but just as there are decisions at the national level which need to be implemented, so must there be decisions at the level of universities or certificate-granting colleges which need to be operationalized after having been founded on proper information and analysis. Generally speaking, all key actors in Higher Education are in fact involved in its planning process: Governmental Authorities setting general education policy; top officials responsible for Higher Education at national, provincial and local levels; officers responsible for institutions of Higher Education; students; professors, public and private employment sectors; etc., and, naturally, officials of the Planning Bureau.

5. Given the vast scope of the questions related to Higher Education Planning and which may cover complex issues such as student admission, flows and output; selection of programmes; establishment of institutions; training, selection and appointment of teaching staff; institutional planning and control; information links and feedback between employment sector and institutions; students organization and welfare and scores of other issues, this paper will limit itself to one aspect of the planning process: distribution of responsibility between various levels of government and the concomitant issue of decentralization as it relates to the issue of financing of higher education.

Decentralization

6. The very use of the word subsumes the starting concept: centralization. In effect, this means that the *central* government authority is the sole source of power. It raises revenue, it alone decides how much of it will be spent for which sector, i.e. Education—or more specifically: higher education—within that sector, it alone decides how the funds are to be spent (which institutions will receive what types and combination of inputs—teaching and learning: equipment and buildings; fungiable goods, etc.). In some cases, the centralized power—usually removed from all loci of exercise of its power—may delegate its authority to agents closer to these loci. This delegation or extension of its powers provincially or locally, is known as *deconcentration* as it alters nothing in the pattern of the central Government's 'Monopoly' of authority concerning objectives and instruments ('means and ends') to actualize—or operationalize - its own policy. Simply, its own

'actors' (Central Government officials) are moved from the capital city to provincial or local levels for more rapid implementation and control.

7. The alternative to this mode of power structure is theoretically its symmetrical opposite: *decentralization.* The pure decentralized model supposes: (i) that the *revenue-base* is autonomous. In other words, that the financial resources required will be provided by the decentralized authority. From, say, its taxes, it will fund all higher education activities it is to be responsible for. It may also use other human and material resources belonging to it and put them at the disposal of higher education (e.g. transfer a secondary school building to a soon to be established university, etc.). Finally, it alone decides on the modes of mobilizing its revenue, by setting alone its own tax rates, without constraint or control from another government structure. Central government setting tax rates for Provincial and Municipal authorities does not correspond to an ideal model of decentralization; (ii) that the level and purpose of spending is entirely in the hands of the decentralized authority. It is that authority which decides how much of its total resources should go to education and within such an amount how much should be directed to Higher Education and—at this level - how much should go to each institution under its control. In so doing, it sets up its own standards for resource allocation without supervision or control from another authority; (iii) it is also at the same level that each institution is directly administered by the decentralized authority: professors are appointed, equipment and supplies are directly purchased and investment decisions are made. All these respond to timing and quality criteria set exclusively by the decentralized authority.

8. An extreme form of decentralization may lead to *privatization* of Higher Education, leaving it to each institution to find its own resources without any support or interference from any governmental authority and, further, assigning responsibility for accreditation of programmes, teaching requirements, etc., to a non-profit but non-public organization (see paragraphs 13, 14 and 17 below).

9. In reality, *pure* models of either *centralization* or *decentralization* do not exist. There is always a certain degree of autonomy left to Higher Education institutions in centralized systems and—conversely—a certain measure of government control, standard setting and even support in decentralized systems. Thus, in a centralized system, such as France where the central government's Ministry of Education finances all institutions at that level, the latter, nevertheless, may benefit from regional or municipal support as well as from national authorities (National Council for Scientific Research) other than the Ministry of Education. In typically decentralized systems such as they exist in the Federal structures of the USA, Canada, Australia, Brazil, etc., the central government may in some cases regulate the level of taxes (Brazil), transfer resources for, or actually take over direct financing of, higher education at States' level. In Australia, there is increasing Commonwealth (Central Government) involvement in supplying financing of Higher Education. In Brazil, most high level universities in the States are federally (Central Government) funded. In general, it needs to be recalled that the pace and nature of decentralization for Education cannot be fundamentally different than those generally applicable to other sectors of Governmental authority as such measures are rooted in nationally applicable constitutional provisions.

10. These mixed systems are necessary to ensure respect, to the maximum degree possible, of the double criteria of efficiency *and* equity:

a) The *efficiency* criterion tends to take the solution generally in the direction of more decentralized forms of organization. This can be explained by the fact that local taxes and other revenue authorized locally (fees, for example) reflect the real potential of

a circumscribed area (region or locality) as it assessed by those responsible for running it and who know it well. Thus self-financing reflects a measure of self-responsibility. Furthermore, decentralized formulae tend to lead to a lowering of costs both of inputs (teaching staff, equipment, construction) and of administration (cutting the 'red tape' and delays between the centre and regional or local forms of Government), although lack of local managerial skills may sometimes tend to offset this latter advantage;

b) The *equity* criterion, conversely, pulls the system towards a greater degree of centralization. This finds roots in the fact that the Revenue-base—or taxing potential—varies considerably from one Region to another and within Regions—or Provinces—from one part of it to another. These inter-regional or intra-regional disparities affect the level of resources which may be mobilized for education in general or for higher education in particular and thus have a direct impact on the amount and quality of educational services which may be made available to each citizen demanding—or being entitled to—such services. This difference and corresponding inequity between 'rich' and 'poor' decentralized units is further compounded by the 'brain drain' phenomenon which generally pulls away from poorer units students and certificate or degree-holders who after having been educated in these areas and at their cost choose to leave them for income-earning activities in 'richer' areas which further benefit from additional revenue through taxes being paid by these internal migrants.

11. A further potential injustice flowing from decentralization is the local determination of the amounts to be *spent* on education in general, on higher education in particular, and more specifically on specific types of higher education. This mode of allocation of resources runs the risk of being arbitrary and may favour one particular group (urban dwellers, for example) and discourage others (remoteness of institutions due to lack of transport or boarding facilities, for example). Finally, it may be said that decentralization may favour injustices to the extent that strong political influence from local leaders in favour of their 'clientle' may not be in the interest of an equitable supply of educational services to all.

Mode of financing

12. With the reservations already mentioned about the absence of 'pure' centralized or decentralized models, it might be expected that for each model, there is a corresponding mode of financing. For example, it could be supposed that the centralized model is founded on exclusive Government Financing and Control while the decentralized model is financed totally out of resources either due to the institutions with no 'strings' attached or which they can themselves mobilize: i.e., fees, contracts, etc. In reality, higher education institutions benefit from a combination of funding sources whether they are in centralized or decentralized systems. That is why three separate modes of institutional financing will be examined although, in fact, not one of them is the exclusive source of a given institution. Rather, a 'mix' of them may reflect more adequately the actual prevailing modes.

Financial independence

13. This type of financing comes from a variety of sources. In many US universities, for example, this takes place through endowments for investments yielding an income and financial gifts from former students. In most Latin American countries, this is obtained through a constitutionally earmarked share of the National Educational Budget with no control whatsoever (autonomy being synonymous with non-accountability). In the United

Kingdom, this takes the form of 'Block' transfers from the Government to a Commission 'University Grants Commission') made up of academic representatives (excluding political and government representatives) which, in turn, sets up and applies criteria for allocating these resources to higher education institutions, each institution deciding how to use these alloted funds.

14. The disadvantages of this mode is that it may be difficult to implement a *national* policy as each institution, and conceivably the University Grants Commission may have a divergent position; that in each university, there may exist powerful pressure groups or vested interests that will legislate in their own favour (salaries of teaching staff, for example) and, finally, that in a rather smaller unit, such as a university, hard decisions concerning curriculum are bound to affect individuals against whom measures are often difficult, if not impossible, to take.

Government control

15. In this mode of financing, there are no 'Block' Grants (transfers with no conditions) from Central, Provincial or City Governments but specific conditions are attached to the spending of each budget sub-heading; the institutions being allowed a limited degree of freedom of spending *within* budget sub-headings. In France, for example, a central Ministry of Education transfer to a given University means that any expenditure item, even within a budget sub-heading, can only be spent after *a priori* authorization and is subject to *a posteriori* control.

16. Naturally, the advantages of this system are symmetrically opposed to the disadvantages of the independent system: easier to implement national policy, government makes the 'difficult' decisions about bud and cuts and is responsible for ensuring the financing. The disadvantages are no less obvious: decisions are often made slowly and bureaucratically, divorce between fund suppliers and spenders make for inefficiency as 'spenders' ask for more than what they actually need and are the sole authority effectively aware of the real situation. The main criterion for resource allocation is 'incremental' growth based on previous year's allotment allowing for financing of new incremental activities. In addition to leading to 'rushed spending' at the year's end to avoid unused allocation, it favours continuation of activities approved in the past but which may no longer correspond to priority spending (opposed to this system is the 'Zero Base' procedure imposing a total evaluation of all activities—to be judged on the basis of their relative priority—for each budgeting or planning period).

Sale of Services

17. This mode of financing is neither in the hands of political and governmental authorities, on the one hand, or of academies, on the other. It relies on a variety of decision-making centers which constitute what might be called the 'market forces' of demand. Academic and financial decisions are made by the 'consumers' of the educational product. Thus educational services are supplied to students, or their future employers, in exchange for fees while research or consultancy services are supplied to public or private 'customers' in conformity with the terms of a commercial contract. Universities, thus are made to respond to changing *external* circumstances as they must provide services attractive to students and economically rewarding to research and consultancy customers. This system prevails in many universities in the USA, in Japan, the Philippines, India, Brazil, Mexico, etc.

18. The obvious disadvantages of this system is that if left entirely without control, it would bring about flagrant injustices to individual potential students by favouring those who can pay fees and favouring specific programme areas likely to yield more research or consultancy contracts. It is therefore essential that such a mode be tempered by other measures in order to ensure that it be a *complement* to government financing and not a *substitute* for it. These measures imply the use of public funds for supporting poorer and worthy students and the existence of high level admission criteria to favour principally worthy students among those who can pay fees.

19. In many countries (Colombia, Mexico, India, France, etc.) this is accompanied by student loans schemes permitting individual candidates to borrow the necessary funding for payment of fees and boarding costs under the condition that they commit themselves to gradual reimbursement upon employment subsequent to graduation. The principle advocated in the United Kingdom (Robbins Report, 1963) and in the USA (Carnegie Report, 1981) is that *all* students should pay fees and that—simultaneously—partial or full reimbursement to students be guaranteed by the Government.

20. Ideally, such a system should rely on an information feedback mechanism for students faced with what is an irreversible and independent decision concerning their future career. They should know about likely employment opportunities upon their availability on the employment scene, for example. While this may be very difficult to achieve with a high degree of accuracy for obvious structural and conjunctural reasons, the present base of which these decisions are made could be improved through the establishment of independent advisory and counselling services for students.

21. The second measure which may temper the excesses of the 'sale-of-services' mode lies in the establishment of Central Research Councils by specific areas (different specialists of engineering, medicine, biology, etc.) which could award research contracts to the best 'bidder', i.e. the most competent University or Faculty. This could also lead to Adult Education Councils awarding contracts to the University offering the best supply of services. Such a device would ensure that no University or College have a guaranteed income and that their survival actually depend on their ability to provide services deemed to be useful to 'external' communities, thus doing away with unchanging priority programmes.

Conclusion

22. From the above, it may be seen that the Planning process in Higher Education as it relates to its financing cannot be compartmentalized according to a typology based on the degree of decentralization established by policy makers. By its very nature, Higher Education must respond *both* to efficiency and equity criteria.

23. To meet *efficiency* objectives, it will attempt to reduce costs and increase its effectiveness (some might use the word 'profit'). This will be achieved by optimizing resources and being alert to the 'signals' of employers. In general, this may favour decentralized modes of action

24. But it must also respond to *equity* goals and ensure *all* citizens benefit from an equal chance of access while higher education fulfill at the same time its social and cultural function—not limiting its evaluation of degree or certificate holders to their contribution to economic development alone. This tends to favour some control by the Government which is expected to represent the general welfare of the population and not limit its concern to

25. It may thus be said that while Higher Education institutions must respond to the specific and general demands thrust upon them, only the State (the Federal Government, the Commonwealth Government, the Semi-Federal or the Higher Centralized Government) can ensure the balance between conflicting interests and help bridge imbalances and disparities.

Lecture 9

Analysis of the use of resources devoted to higher education and the way they are financed

Ta Ngoc Châu

Objective of the analysis

In such an analysis one should focus on:

- the allocation and use of *real resources*
- the allocation of *financial* resources
- the *unit expenditure* and its disparity among various type of Institutions
- the *relative contribution* of the different financing sources.

Allocation and use of real resources

By real resource one means personnel, building, equipment, material which are allocated to and used by the institutions. Real resources and the financial resources to which they correspond are two aspects of the same phenomenon. However, it is more convenient and clearer to assess the use of real resources.

Allocation of real resources is a complex process which may take place at different levels of administration. One may distinguish for instance the allocation of resources from the Province to the Institution and allocation of resources within the Institution. The resources allocation process can be analyzed from the point of view of:

- the rules and the criteria which govern that process
- the information used in that process
- the decision-making mechanism.

There is obviously close relationships between allocation of resources and use of resources. Bad resources allocation may lead to inefficient use of resources.

To assess the use of resources different kind of indicators can be used. In the case of teachers, for instance, the most commonly used—although not necessarily a very significant indicator—is the number of students per teacher i.e. the student/teacher ratio.

"The student/teacher ratio in Chinese universities is low by comparison with other countries. The ratio for universities that provided data for this report is 3.7 to 1. The average for universities in East Asia and the Pacific, including China, is about 12 to 1. It is about 10 to 1 in the United Kingdom, 15 to 1 in the United States and 25 to 1 in France.

These conditions in Chinese universities derive from several historical factors that have now begun to change."[27]

As we have said the student/teacher ratio is not a very significant indicator and should certainly not be used alone. The problem therefore is not to increase the student/teacher ratio but to understand why it is lower in China as compared to other countries and whether this is justified.

From an analytical point of view, some other indicators may be more relevant such as:

- the working load of different categories of teachers and its distribution between research and teaching
- the size of group according to different educational activities
- the teaching-learning method used.

In addition, the assessment of the use of teachers should be linked to the assessment of the results obtained and more precisely in terms of student achievement.

Teachers constitute an important part of resources devoted to Higher Education. The assessment of the efficient use of teachers is therefore essential. The same attention should be given to the efficient use of Building and equipment which are also two key elements of the resources of Higher Education.

Allocation of financial resources

As we know there is a large diversity of Institutions in Higher Education. It would be interesting to look at the allocation of resources to different type of institutions. The report on Management and Finance of Higher Education gives the information in Table 23 about Public expenditures on Higher Education.

At first sight, regular higher education seems to absorb a very large share of total recurrent expenditure. Such conclusion should however be taken with much caution because the table does not include all the financing sources. For instance, no information is given for the workers colleges because the workers colleges are not financed by the State.

In order to make a meaningful analysis of the allocation of financial resources it is necessary to make sure that all the financing sources are included in order to avoid biased interpretation of the data.

For the reason just given, it is not possible to relate the figure on public expenditure with the statistics concerning the number of institutions and enrolment in Higher Education.

[27] World Bank, East Asia and Pacific Regional Office *China: Management and Finance of Higher Education*, 1986, p. IV.

Table 23

Estimate of public expenditures on higher education (1983) (millions yuans)

Regular higher education	
Conventional universities	2 374
Polytechnics	20
Sub-total	2 394
Adult higher education	
Television universities	75
Workers colleges(a)	-
Correspondence, special & evening programmes	104
Others	160
Sub-total	339
Total of recurrent expenditure	2 733

(a) Workers Colleges are, in general, not financed by the State.

Source: World Bank, China: Management and Finance of Higher Education, *op. cit.* p.87.

Statistics on enrolment in Higher Education as those shown in Table 24 may raise another problem. While enrolment in regular higher education corresponds to full time students, enrolment in Adult higher education relates to a large extent to part time students, the proportion of part time students changing from one type of institution to the other.

The two previous examples give an idea about the need for a complete information and the problem raised by data interpretation.

Unit expenditure analysis

By unit expenditure we mean average expenditures per student. Unit expenditure analysis can only be done at the institution level. It requires that all financing sources or revenue sources be clearly identified and that all expenditures be taken into account.

To do such an analysis, a special survey at the Institution level is most of the time necessary.

Table 24

Enrolment in Higher Education 1983

	Number of Institutions	Enrolment 000'
Regular higher education		
Conventional universities	805	1 187
Polytechnics	55	20
Sub-total	860	1 207
Adult higher education		
Television universities	29	500(a)
Workers' colleges	840	170(b)
Correspondence, special and evening programmes	-	298(c)
Others	322	160(d)
Sub-total	1 191	1 128
General total	2 051	2 335

(a)Of this number about 50% were enrolled in full time study in 1983.

(b)Of this number about 20% were enrolled in full time study in 1983.

(c)These programmes are conducted either directly by or with the assistance of conventional universities.

(d)This category includes universities of peasants, independent correspondence colleges, institutes for management training for cadres and institutes for in-service teacher training. Teacher-training accounts for about 80% of the total.

Source: World Bank, *China: Management and finance of higher education, op. cit.*, p. 11.

Such a survey has been conducted in 1981-1982 and covers a sample of 67 higher education institutions distributed in the following way:

Agriculture, forestry, fishery	3 institutions
Science and technology	21 institutions
Economics, finance and law	3 institutions
Comprehensive education	16 institutions
Normal education	21 institutions
Medical education	3 institutions
Total	67 institutions

The detailed results of this survey are presented in the report 'China: Management and finance of Higher Education'.[28]

The data given in Table 25 summarize some of the findings of that survey. For clarity sake, unit expenditures have been regrouped into three broad categories:

- Direct instructional expenditures
- Expenditures for students, and
- Other expenditures

The total recurrent unit expenditure range from 860 yuans for institutions specialized in Economics and law to 2403 yuans for Agricultural Institutions.

On average, Direct Instructional expenditures account for 47% of total recurrent unit expenditures, expenditure for students (Boarding and subsidy) 20% and other expenditures (including administration and maintenance) 33%.

A large part of the variation of total recurrent unit expenditures result from the variation in direct instructional expenditures. Unit expenditures for teacher salaries vary from 154.8 yuans to 432.5 yuans. This may be due to differences in the qualification of teachers in the various type of institution, but this may also be explained by the differences in the student/teacher ratio resulting from the differences in the organization of the teaching-learning process.[29]

For obvious reasons the instructional recurrent expenditures change very much from one type of institution to the other. This may be linked to the speciality offered. However, since instructional recurrent expenditures account for a sizable proportion of total recurrent unit expenditure, they deserve a careful analysis, which can be done only on the basis

[28] World Bank, *op. cit.* pp. 29-33. See also the questionnaire used in the survey in Annex C of the same report pp. 101-106.

[29] In spite of what has been observed previously about the student/teacher ratio, the proportion of expenditures devoted to teacher salary seems to be relatively low in Higher Education Institutions in China.

Table 25

Average unit expenditure by type of institution of higher education

	Type of speciality					
	Econ. Law	Comp. Educ.	Normal Educ.	Medic. Educ.	Science Techn.	Agric. Educ.
Direct instructional expenditure						
Teacher salaries	154.8	226.8	218.5	431.2	343.2	432.5
Inst. recur. expend.	189.2	280.8	333.5	400.4	390.0	744.9
Sub-total	344.0	507.6	552.0	831.6	733.2	1 177.5
Expenditures for students						
Mat. & supply for boarders	43.0	75.6	92.0	123.2	140.4	216.3
Subsidy to students	103.2	151.2	195.5	107.8	156.0	192.2
Sub-total	146.2	226.8	287.5	231.0	296.4	408.5
Other expenditures						
Administrator salaries	94.6	86.4	115.0	123.2	124.8	168.2
Other staff salaries	51.6	97.2	69.0	77.0	140.4	144.2
Transportation	180.6	21.6	34.5	154.0	31.2	72.1
Maintenance	43.0	140.4	92.0	123.2	234.0	432.5
Sub-total	369.8	345.6	310.5	477.4	530.4	817.0
Total recurrent expenditure	860.0	1 080.0	1 150.0	1 540.0	1 560.0	2 403.0

Source: Compiled from data given in World Bank, op.cit., p.31.

of more detailed information.

Differences in expenditures for students result mainly from expenditures for material and supplies for boarders. Here the reason can be quite specific and can be identified only by a careful analysis of expenditure at the institution level.

In so far as the other expenditures are concerned one can note a wide variation for transportation and maintenance. Such an observation, however, is not very helpful unless we can identify clearly the reasons which may explain the variation.

From what we have seen about unit expenditures it seems that two preliminary conclusions can be drawn.

The first one is the need for a carefully designed classification of expenditures allowing for a better understanding of the differences among the various type of institutions. Such a classification would facilitate the collection of relevant data and would allow a better analysis and understanding of the present situation.

The second one is that there is a very large diversity of institutions in Higher Education with quite sizable differences in unit expenditures. The projection of resource requirement is therefore a rather complex task necessitating a thorough analysis of the present situation and the exploration of all possible consequences resulting from policy change.

The relative contribution of different financing sources

Revenues for the operations of Universities and other Institutions of Higher Education in China have been almost exclusively governmental. These governmental sources include:

- The State Education Commission
- The Provinces
- The Technical Ministries
- The Technical agencies at national level
- The Technical agencies at regional level.

It is important to identify the relative contribution of these different financing sources. In addition, with the changes that have taken place in the economic structure of China in recent years, many institutions, particularly in the larger universities and the specialized universities of technology, have developed new sources of revenue. According to the report on Management and Finance of Higher Education these new sources are:

- Contracts with enterprises or governmental units for training their personnel;
- Consulting and research services;
- Student fees;
- Other miscellaneous revenues.

(a) Contracts with enterprises or governmental units for training their personnel

These contracts 'derive from the acute need for specialized and technical personnel of many enterprises or governmental units and the willingness of these major entities to finance employees' education. Many of these units have developed contracts with universities for the training of their personnel. These training contracts are now providing an additional source of revenue for the institutions and for the faculty who teach the courses. At one comprehensive university in the Northeast, business enterprises in the area have agreed to pay Y 2,300 per student per year for training workers in special courses. Of this Y 2,300, Y 1,300 is used by the university to cover operating expenses and Y 1,000 is set aside for capital construction. The Y 1,300 is divided as follows: 40% to the university central budget to cover general administrative expenses; and 60% to the academic department responsible for the program for faculty support, department development, equipment funds and other departmental needs. In 1984, this source provided some Y 705,000 or approximately 7% of total recurrent expenditure.'[30]

[30] World Bank, China: Management and Finance of Higher Education, *op. cit.*, p. 64.

(b) Consulting and research services

'In addition to the need for trained personnel, governmental units and enterprises increasingly require consulting and research services in fields such as technology development, marketing, application of computer technology, and management. Many universities are able to provide assistance in these areas, and governmental units and enterprises are now contracting with universities for these specific research needs. In a major university in the Northeast, these research funds in 1984 amounted to some Y 920,000 or about 9% of total recurrent expenditure.'[31]

(c) Student fees

"Although full-time students in conventional universities in China have not paid fees or charges, according to the recent *Decision on Education Reform* students may now be admitted outside of the state planned enrollment quota, and charged fees. Other students who enroll in night courses, short courses, and correspondence courses are also charged fees. In some cases, the students pay these charges out of personal or family income. In other cases, enterprises will pay these fees in contribution to the upgrading of their employees. At a major medical university in north China, for example, evening students pay Y 340 per year for university courses if they are employed by an enterprise or Y 200 per year if they are not currently employed. Students who are employed may be reimbursed by their employer for these fees. To date, the amount collected at this university from this source amounts to about Y 40,000 per year, not a significant sum in comparison with total operating budget, but apparently sufficient to defray costs of new educational programs designed to serve local needs.". 6 .[32]

(d) Miscellaneous revenues

"There are also revenues which arise from activities carried on as auxiliary to the educational function. These revenues arise from the sale of books and materials to students; receipts from the operation of dining halls and guest houses; and revenues from operations of general stores and book stores by the university. Many educational institutions also operate printing presses for the printing and publication of textbooks and other instructional materials. These presses obtain income in the sales of their product to students, faculty and others. As a part of the laboratory training of students or the research interests of the faculty, some universities have also created 'factory sales', that is, the manufacture of specialized equipment which is in demand by other universities or enterprises. A further source of revenue, of lesser amount now but a source which could grow in the future, are private gifts or contributions from a number of sources, overseas Chinese who wish to support a given institution, graduates supporting their university in partial repayment of the training they received, or enterprises contributing to the institution from which they obtain graduates."[33]

[31] Ibid. p. 64.

[32] Ibid. p. 64.

[33] Ibid. p. 65.

Lecture 10

Building an information system for educational management and planning

by Ta Ngoc Châu

During the early sixties educational planning experienced very rapid development and was gradually introduced in nearly every country. The hopes placed on planning were immense. It was expected to act as a framework for the setting of goals and priorities, to permit improved guidance of the expanding educational system in the light of economic, social and cultural development needs and achieve optimal use of the limited resources available for education.

At that time, the dominant planning model was basically the techno-rational model. In 1964 Morton White published a book, the title of which was quite revealing 'The Age of Analysis'[34] both in terms of the power attributed to analysis and the eminent role of those who are in charge of doing it. Around that techno-rational model a series of techniques has been developed under the umbrella of the System's approach:

> 'Essentially the system's approach involved viewing any productive systems as a whole in order to examine how its productive process functions in relation to its resource 'inputs' and its intended 'outputs'. This analytical approach can be usefully applied to all sorts of productive systems, including an educational system and its various sub-systems.
>
> A 'systems analysis' begins by defining as precisely as possible the objectives to be sought. It then proceeds to identify the various alternative ways by which these objectives might be attained and to weigh the relative advantages and disadvantages of alternative approaches in order to select the most effective feasible and economical one. Having chosen what seems the best alternative, it proceeds to elaborate a plan of action, including a timetable, a definition of actions to be accomplished during each phase, the various resources that will be required along the way, the nature and timing of results anticipated, and practical means for regularly evaluating progress and for making necessary changes in the initial plan.'[35]

Looked upon in that way, the planning process became above all technical. Reference, of course, is made to the need for defining precise objectives but not really as an issue. Reference is also made, but only indirectly, to implementation through the necessity of regular evaluation. The emphasis, in fact, is put on the identification of alternatives and the selection of the 'most effective, feasible and economical one.'

The various techniques which have been developed within the framework of the system's approach, notably cost benefit analysis, operations research, simulation models, sensitivity analysis, can be considered as tools for helping decision-making. They constitute the basis for the selection of alternatives and their common characteristic is the

[34] Morton White. *The Age of Analysis*,. New York, Mentor Books, 1964.

[35] W. Schram, et al. *The New Media, Memo to Educational planners*. Paris Unesco/IIEP, 1967 p.162.

search for efficiency in the use of available resources.

Right at the time when these techniques were being developed, various objections were formulated. The most common one is that these techniques are essentially quantitative. Although they may be based on better information and on more thorough analysis and in that way improve decision-making, the information they use relates only to quantifiable aspects. Putting the major stress on these aspects leads to attributing too great an importance to them and, consequently, to neglecting other aspects which may be equally important.

In fact, the principal objection which can be presented to the techno-rational planning model is that it over simplifies the planning process. By emphasizing the technical aspect, it has made planning a matter of expertise. By concentrating attention on the search for the 'best' alternative, it has transformed the formulation of the plan into the aim of planning itself with the optimistic assumption that a technically sound and coherent plan would be implemented without problems.

The education system is a massive organization with many levels of decision-making and with multiple action centres disseminated all around the country. Within such a system, decisions have to travel quite a long way before reaching the points where they are executed. They have to go through many relay-stations with all the chances of being distorted sometimes because they are misunderstood but often because they are not accepted willingly. In such a massive organization, involving so many actors and submitted to so many pressure groups, changes can be introduced only marginally and the margins of manoeuvre are, in fact, quite narrow. It would therefore seem somehow unrealistic to speak of alternatives. It may be more relevant to refer to the notion of 'incremental politics' as defined by Charles Lindblom.[36]

In these conditions the concern cannot be restricted to the search for the optimal solution in the sense of operations research; the concern should also be given to the degree of acceptability of decisions and the probability of their being implemented.

Not only is it realized that changes are difficult to introduce but the nature of the changes required has also changed. During the fifties and sixties the shortage of qualified manpower was acute, access to education at various levels so limited that the main problem was that of expansion, i.e. more of the same thing. Today, after thirty years or so of expansion, new problems have emerged: inequality in education, graduate unemployment, technological gap. The changes required because of these problems are much more complex: change in attitudes and in expectations, introduction of new subjects requiring new training methods, need for continuous updating of knowledge.

Planning is and will continue to be the necessary instrument to influence and to shape the future, to set medium and long-term objectives. However, it can no longer be a set of predetermined and rigid measures to be implemented mechanically. It should conversely be a continuous, motivating and learning process, implying a permanent dialogue between the various levels of management, allowing for a real feedback and adaptive or corrective action.

[36] Charles Lindblom, 'Still muddling, not yet through', Public Administration Review Vol. 39, 1979, pp 517-518.

The planning process, the main features of which we have just underlined, varies of course from one country to another, depending on its socio-economic, political and administrative context. It can be more or less centralized, it can be more or less democratic and participative. It does have an effect upon the type of information needed, the way information is used at each level of administration and the flows of information from one level to the other. The planning process, the way it operates, the actors who participate in it, have therefore a decisive influence on the design of the information system which is meant to serve it.

The essential role of an information system is to transform data into meaningful information which may be used in the decision-making process. We will, therefore, deal firstly with the use of information in the decision making process.

Information and decision-making

No one would dispute the importance of information as a basic element in the decision-making process. However, in real-life, decisions are often made based on incomplete, and often unreliable information.

In view of the complexity and fickle nature of real-life situations (and also, of uncertainty regarding the future), the volume of information necessary—directly or indirectly—for making decisions could be tremendous. The remarkable breakthroughs made in the field of information technology allow us to deal technically with such large volumes of information. But the problem still remains of determining how the decision-maker can make the best use of this mass of information.

The decision-making process

When analyzing the decision-making process, there is a tendency to focus on the final phase of decision-making, in other words, the moment when the decision is actually made. Our attention is drawn to the personality of the person making the decision and the context in which he finds himself.

However, it would be better to define the decision-making process in broader terms. Herbert Simon describes it as follows:

> 'In treating decision-making as synonymous with managing, I shall be referring not merely to the final act of choice among alternatives, but rather to the whole process of decision. Decision-making comprises three principal phases:
>
> - finding occasions for making a decision
> - finding possible courses of action
> - choosing among courses of action.
>
> These three activities account for quite different fractions of the time budgets of executives. The fractions vary greatly from one organizational level to another and from one executive to another, but we can make some generalizations about them even from casual observation. Executives spend a large fraction of their time surveying the economic, technical, polit-

ical and social environment to *identify new conditions that call for new actions.* They probably spend an even larger fraction of their time, individually or with their associates, seeking to invent, design, and develop possible courses of action for handling situations where a decision is needed.

They spend a small fraction of their time in choosing among alternative actions already developed to meet an identified problem and already analyzed for their consequences.

The first phase of the decision-making process—searching the environment for conditions calling for decision - I shall call *intelligence* activity (borrowing the military meaning of intelligence).

The second phase—inventing, developing, and analyzing possible courses of action—I shall call *design* activity.

The third phase—selecting a particular course of action from those available—I shall call *choice* activity.'[37]

With this extended definition of decision-making, two important points deserve to be underlined:

- The first is that *this process is not linear.* It is not made up of three distinct phases which come one after the other (and which can be handled, if necessary, by different groups of people). The process is essentially an iterative one. *While looking for solution* we might conclude that the problem is poorly defined or worded or that it lacks certain essential information that should be included. Likewise, *the process of choosing a solution* can lead to unexpected consequences, with the result that all the proposed solutions must be rejected and totally new solutions sought, or, even, that the problem must be completely redefined.

- The second point concerns the nature of information, and the way it must be handled, which is relatively different at each of the three phases of decision-making. A broad definition of the process allows us to clarify and better identify information needs.

The way we have defined decision-making makes it very similar to the process of finding a solution for a clearly-stated problem. There is, however, one basic difference. The solution to a problem (especially a theoretical one) is usually not urgent. This is not the case for decisions, where the costs for delaying actions are often extremely high.

Identifying the problem

This aspect of the decision-making process, which Herbert Simon calls intelligence activity is often under-estimated or even ignored. It is however an essential aspect of the process. Too often, problems come up suddenly and we try to solve them on the spot. Obviously, it would be better to solve them before they get too serious because, in such circumstances, finding a solution becomes much more difficult. This is possible when we suspect a problem might arise in the future and that the system can be efficiently monitored. Things are quite different in the case of new and unexpected problems.

[37] Herbert A. Simon, *The shape of automation for men and management* Harper and Row, New York, 1965, pp. 53-54.

For example, we could say that a system of higher education always functions within a certain environment. This may seem like stating the obvious, but it shows that 'intelligence activity' concerns not only the internal functioning of the system but also and especially the interrelations between the system and its environment. Too Frequently there is an imbalance between the information we have on the internal functioning of the system and what we know about the inter-relationship between the system and its environment. We will come back to this point later on.

Seeking alternative courses of action

There are two major aspects to be considered here. Firstly, to what extent the suggested *actions* are really related to the problem as it has been defined, and how much they will help towards its solution. Secondly, what are the consequences of these actions, first of all the immediate ones, especially in terms of extra resources that will be needed, and then, in the longer term, on the functioning and output of the system.

The procedure we follow might be based on the *past experience of the system.* We could, for example, simulate the implementation of these actions based on the past and present functioning of the system in order to predict the consequences for the future. We are assuming in that case, that the action taken *will not in itself lead to any major changes in its operation.*

We might also base our search on the experience of other similar systems. In this case, predictions of the operation of the system are, for obvious reasons, much less reliable.

It is to be pointed out that when searching for solutions we must not make the problem too rigidly defined. We must be able to clarify or even reformulate the problem along the way. For this reason, intelligence activity and the search for possible solutions of a problem are interrelated.

Choosing among courses of action

The very fact that we speak of choosing among courses of action implies that there is no one optimal solution, strictly speaking, since if there was only one optimal solution, the decision would be automatic, and there would be no choice to make. Since the end of the Second World War, considerable progress has been made in the field of operations research, and later on we have seen the development of a branch of mathematics known as Decision Theory. This progress, together with the increased capacity and processing speed of computers, has allowed us to solve increasingly complex problems. Nevertheless, as Charles Hitch, a well-known specialist in operations research has put it:

> 'I would make the empirical generalization from my experience at RAND and elsewhere that operations research is the art of sub-optimizing i.e. of solving some lower-level problems, and that difficulties increase and our special competence diminishes by an order of magnitude with every level of decision-making we attempt to ascend. The sort of simple explicit model which operations researchers are so proficient in using can certainly reflect most of the significant factors influencing traffic control on the George Washington Bridge, but the proportion of the relevant reality which we can represent by any such model or models in studying say, a major foreign

policy decision appears to be almost trivial.'[38]

Following in the same line of thought, Herbert Simon speaks of 'mathematician's aphasia':

> 'Some relatively simple management problems turn out to be far too large for even such a powerful tool as linear programming. This leads to an ailment that might be called mathematician's aphasia. The victim abstracts the original problem until the mathematical intractabilities have been removed (and all semblance to reality lost), solves the new simplified problem, and then pretends that this was the problem he wanted to solve all along.'[39]

This is why Herbert Simon prefers to speak of satisfying rather than optimal solutions. The choice of this satisfying solution is above all a question of judgement. In fact, possible solutions are not always easily comparable since each solution carries with it different consequences. Choosing one solution—making a decision—means making a value judgement, expressing a preference for one set of consequences over another. In the social sphere, especially, a considerable amount of modesty is called for. No problem can ever be said to be entirely—and even less so, definitively—solved. While trying to solve one problem, we create new—hopefully less serious—ones.

Categories of decisions

Until now we have been discussing the decision process in general terms. But the type, importance and time considerations of different decisions are far from comparable. Many writers have tried to classify decisions. We have chosen the following three examples as an illustration.

Hierarchical or military classifications

This is an old and familiar classification, which distinguishes between three levels of decision:

- strategic decisions
- tactical decisions
- operational decisions.

This pyramid-style classification is convenient for a bureaucratic structure. It allows us to define and determine the scope of power at each level. It contains, however, many disadvantages since it is quite rigid and considerably reduces the capacity of the organization to adapt to a changing environment.

[38] Quoted by F. Rourke and G. Brooks, in *The managerial revolution in higher education*, Baltimore, Johns Hopkins Press, 1966, p. 10.

[39] Herbert Simon, loc. cit. 3, p.72.

Classification by decision method

This is the classification used by Herbert Simon, who explains it is follows:

> "In discussing how executives now make decisions, and how they will make them in the future, let us distinguish two polar types of decisions. I shall call them *programmed decisions* and *non-programmed* decisions, respectively. Having christened them, I hasten to add that they are not really distinct types, but a whole continuum ... and I use the terms programmed and non-programmed simply as labels for the black and the white of the range."[40]

Programmed decisions, according to Herbert Simon, are decisions which can be programmed in the sense of computer programmes. They concern recognized problems, for which a standardized solution exists. In other words, 'decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them.'[41]

This is an extreme case, with, at the other end of the extreme, non-programmed decisions. 'Decisions are nonprogrammed to the extent that they are novel, unstructured, and consequential. There is no out-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment.'[42]

This classification, distinguishing between programmed and non-programmed decisions is to some extent similar to the distinction made by Rittel and Weber who contrast 'tamed' problems against 'wicked' ones.[43]

In the daily operations of an educational system there are many programmed decisions in the sense of Hubert Simon. For this type of decisions, the information needed can be clearly defined and the way for handling it can be determined since these decisions correspond to problems which are familiar, for which solutions are known and standardized procedures exist.

Many planning decisions, however, are non-programmed decisions. Since we are dealing with new problems, difficult to grasp and not always thoroughly understood, it is difficult to know in advance the type of information which is needed and the way to process it. We will come back to this problem later on.

Classification by type of decisions

Here again, there are three categories of decisions:

- planning decisions

[40] Herbert Simon, *op. cit.*, p. 58.

[41] Ibid. p. 58.

[42] Ibid. p. 59.

[43] Rittel H.W. and Weber M.M. 'Dilemnas in a general theory of planning' in Policy Science. Vol. IV, N 2, 1973, pp. 155-156.

- management decisions
- operational decisions.

This classification is based on a twofold criteria: the scope of the decision (which may be limited or large) and its effects in time (immediate or long-term effect). Figure 8 illustrates the two dimensions of this classification with the scope of decisions measured along the vertical axis and time effect along the horizontal axis.

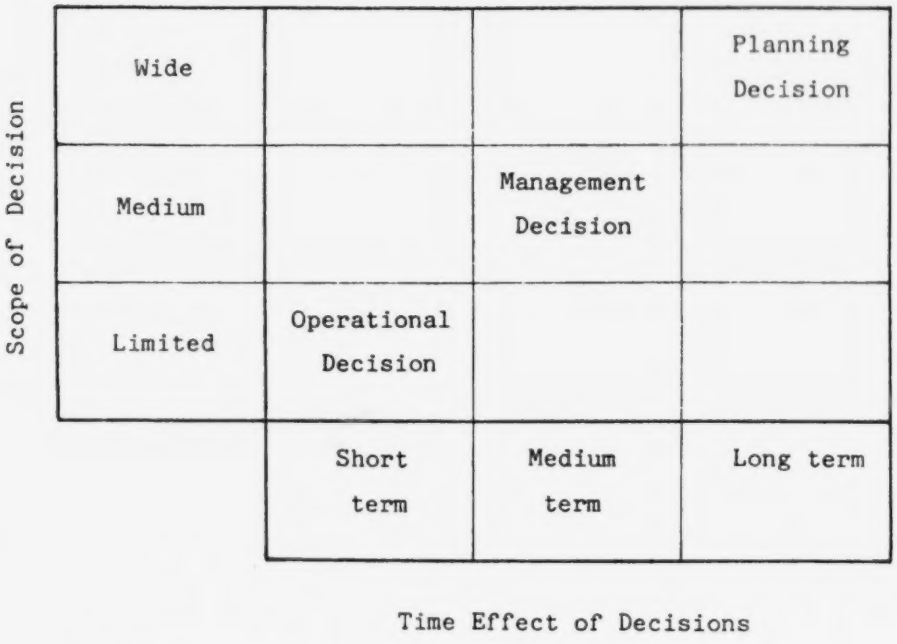


Figure 8: Classification of decision by nature of decision

Although at first glance this classification appears to go along with the hierarchical classification we mentioned earlier. There is, however, an important difference since planning decisions, management decisions and operational decisions do not correspond to any hierarchical administrative levels. Each category may be found at every level of administration.

Planning decisions:

In the diagram we have presented, the planning decisions are located in the upper right part. They are decisions with a wide scope and long-term effects. They correspond to general policy, long-term orientations, global objectives. These decisions are long-term

because, considering the weight (and the inertia) of the existing situation, change can only be marginal and the effects of change can be obtained (or perceived) only through the process of time.

Long-term decision often is constituted by a sequence of interrelated measures to be gradually implemented. This sequence, however, should not be considered as a series of decisions taken in advance which should be mechanically put into effect during the five year period of the plan. A plan does not 'regulate' everything in advance! In reality, long-term decisions should be, inasmuch as possible, reversible, since they may have to be modified because of the uncertainty of the future.

Decisions with long-term effect, of course, are today's decisions. Today's decisions, however, constitute a commitment for the future inasmuch as decisions can be related and linked in a sequence. In such a case today's decisions should be approached from a time perspective. This is the basic idea which is behind the notion of the sliding plan or the PPBS technique.[44]

Management decisions: These decisions concern the actual functioning of the organization. Their scope is less wide than the planning decisions and their effect requires less time. Management decisions often are made in order to implement planning decisions.

Since the effect of these decisions are not immediate, since we do not know what obstacles might stand in the way of their implementation or reduce their influence, since we are not sure that their real effect correspond to what is expected, a careful monitoring of these decisions is necessary. Such monitoring should allow to measure their gradual effects and identify the obstacles to their implementation in order to take the necessary additional, or corrective measures.

Operational decisions: These are the daily common decisions, related to the well known aspects of running an organization. They are of limited scope and have an immediate effect. In general they are based on clearly defined criteria and closely follow previously set rules.

Coming back to Figure 8, as we go from the lower left to the upper right corner, i.e. from operational decisions to planning decisions, we are going from the routine, familiar situation to the more complex, problematic area, from the known to the uncertain. Along the way the type of information needed, the source from which it can be obtained, the way it should be processed in order to be meaningful for decision-making obviously change.

[44] A sliding plan is prepared in conjunction with the budget. Its role is to foresee the effect of the expenditure of the present budget on the level of expenditures during the five years to come. The PPBS (Planning Programming Budgetary System) is a budget system which works more or less like that. When preparing the budget for 1986, one also anticipates the financial consequences for the future. Thus the PPBS is a pluri-annual budget which focuses on the current year.

The role and characteristics of an information system

Starting from what we have seen previously about the decision-making process and about the nature of decision we can now look into the following topics:

- the use of information
- the main components of an information system.

The use of information

The type of information needed, the way it is used depends upon the level of administration and planning. It also depends upon the different phases of the decision-making process.

The use of information at the different level of administration and planning

At the institutional level, information of course is necessary for planning the long term development of the Institution. A large quantity of information, however, is used for management purposes and particularly for ensuring an efficient use of resources.

In the case of Higher Education, the management of Institutions become more and more complex as the institution develops, the number of departments increases and the functions of the institution diversify. (Training, research, cooperation programmes with the industrial sector).

At the *provincial level* information is used for monitoring the functioning of the different institutions and for coordinating their activities. At that level, planning means both controling the development of existing institutions and establishing new ones. One of the basic information needed is the trends of new admissions, their distribution among the different types of specialities and their allocation to the existing institutions and to those to be created.

New admissions depend upon the potential demand of Higher Education, i.e. the number of graduates in the different categories of Secondary Education and their attitudes and motivation towards Higher Education. At the same time, new admissions should also be planned in such a way that those who will graduate can be absorbed by the labour market.

Projection of future manpower requirement is complex because it is based on a set of interrelated assumptions about the overall growth rate of GDP, the specific growth rates of the various sectors of economic activity and about technological change, i.e. the gradual introductions of new technology. Introduction of new technologies, in its turn, modifies the average productivity, the occupational structure and *also* the required qualifications and skills of existing occupations. The introduction of new technologies, in other words, does not only change the occupation mix but also the qualification and skills required.

Thus, most of the information needed for planning new admissions to higher education comes from sources which are *outside* of the education system. In addition this information is based on assumptions about future trends which are *not* under the control of higher education.

At the *national level*, in addition to the coordination of the activity of the institutions which depend directly upon the central ministries, the basic concern is the balanced development of the different provinces. The information required is therefore linked to the problem of allocation (or redistribution) of resources to the provinces in order to reduce *existing disparities* among them.

The kind of information needed and its coverage may therefore be quite different at the various level of administration. One may think of different sub-systems of information, playing specific role at the various level of administration and planning but linked together in a network ensuring an easy and reliable flow of information from one level to the other.

The use of information for problem solving

We noted previously the three stages of the decision-making process:

- finding occasions for making-decision
- finding possible courses of action
- choosing among courses of action.

Problems identification: This 'intelligence' activity, according to the terminology of Herbert Simon, is obviously an essential one. Traditionally, it is done prior to the preparation of the plan under the form of a 'diagnosis', the aim of which is to evaluate the implementation of the previous plan. Often this diagnosis is undertaken on the basis of quantitative indicators allowing to measure deviations from the targets set by the plan or deviations from the norms (particularly in terms of the use of resources) but not necessarily to show the real nature of the problems encountered in the implementation of the plan.

To be useful and efficient, problems identification should be a continuous concern and not an ad hoc operation undertaken on the occasion of the preparation of the plan. It requires a careful monitoring of the various programmes.

This monitoring should not cover the functioning of Higher Education System only but also its relationships with the other sectors, for instance in terms of the employment of graduates.

Problems identification is important precisely because it should lead to the search for possible courses of action. This means that the problem should not only be identified but also understood and this is of course one of the most difficult aspect of monitoring.

The design of alternative courses of action: For problems which are already known to the system, the design of alternative courses of action can be based on past experience particularly if the effect of past decisions have been carefully monitored and evaluated. Extrapolation of past trends, indeed, is often used in planning.

For new problems it might be necessary to rely upon the experience of other systems or of other countries. This does not only mean the need to use information coming from outside the system but also a very careful analysis since the effects can be quite different as the situation and the context are not the same.

Research result in related areas may also be used. Often, however, research results allow to understand better the problem but do not necessarily point out to any specific course of action.

Choice of a course of action: In the social field in general and in the educational field in particular, phenomena are complex and the factors which may affect or influence upon a phenomenon are numerous. Some of these factors are under the control of the decision-makers. Others are not. It is difficult in these circumstances to forecast the possible effect of a decision, particularly the long-term effects.

Yet in order to choose among possible courses of action, it is necessary to compare the effects of each course of action (both the short-term and the long-term effects). This kind of information which, undoubtedly, is extremely useful for decision-making is not easy to provide. Often, it is once the decision made, that one can detect the unforeseen obstacles or the unexpected results. A careful monitoring combined with corrective or remedial decisions are therefore necessary. From that point of view, monitoring should be looked upon as a learning process, a confident dialogue between different levels of administration, the aim of which being to improve decision-making.

The main components of an information system

The essential role of an information system is to transform data into meaningful information which can be used efficiently for management and planning. Schematically an information system can be presented as in Figure 9.

From the previous discussions, we have seen that information needed can come from many different sources. Some of it come from the system itself. In that case it may be easier to collect and to process. But there are also sources of information which are outside the system. Often that information is already processed and have to be used under the form in which it exists.

Within the planning process there are also many users of information who have quite different needs either because they are located at different levels of administration and planning or because they participate in different types of decision-making ranging from operational to planning decisions.

The design of an information system cannot be undertaken without a thorough analysis of the needs of the various categories of user of information. It should be done therefore in close cooperation with them from the treble point of view of the type of data to be collected, the way in which it should be processed and the form in which it should be presented. Information is used inasmuch as it is meaningful to the user.

The main components of an information system are outlined in Figure 10.

- It presents the different activities and their interrelationship: Data collection, Data storage, Data processing and information analysis;

- It shows the different possible ways in which information is communicated according to the type of uses;

- It distinguishes between operational decisions, management decisions and planning decisions since for each of these categories of decisions not only the type of information needed is different but the way information should be processed and analyzed is also

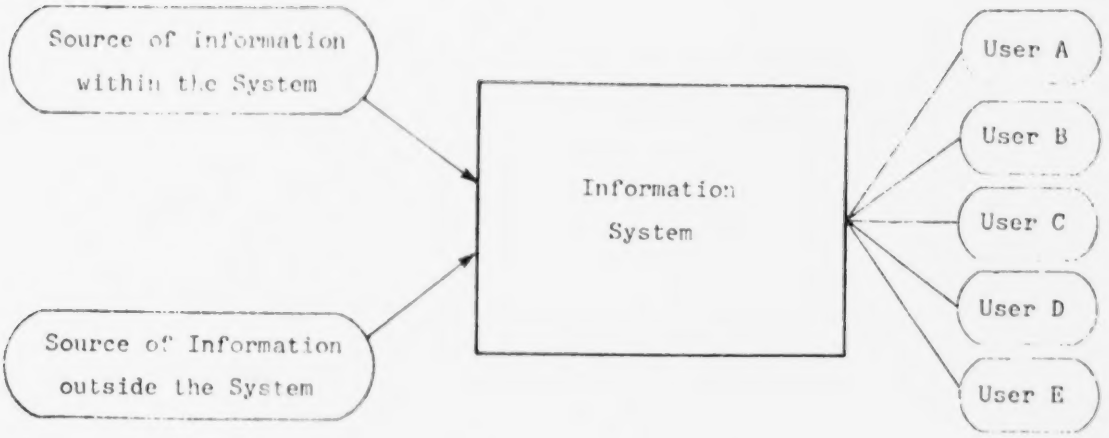


Figure 9: The information system and its environment

different. As we have seen *operational decisions* are limited in scope and have immediate effects. They are made according to existing norms and following standardized procedures. The information needed and the way it should be processed are clearly defined. *Management decisions* have more delayed effect. The time required for feed back information is longer. There is thus the need for careful, continuous monitoring and if necessary for corrective action. *Planning decisions* are even broaden in scope and have long-term effects. They are based not only on the present situation but also on forecast about future trends. Their expected effects are not limited to the system but cover the relationship with other sectors. The range of information needed is much broader, not always clearly defined and of course include a large degree of uncertainty;

- It underlines the fact that information is generated whenever a decision is made: when a teacher is recruited, when a project is adopted, when a budget is approved. The way information thus generated is stored, processed, used or communicated to other level of administration and planning, of course, depend upon the system and the way it is organized.

Data collection

In centralized and hierarchical system, planning decisions are made at the central level. It is also at that level that data are processed and used. The role of the local or regional levels is limited to providing information after checking its accuracy and reliability.

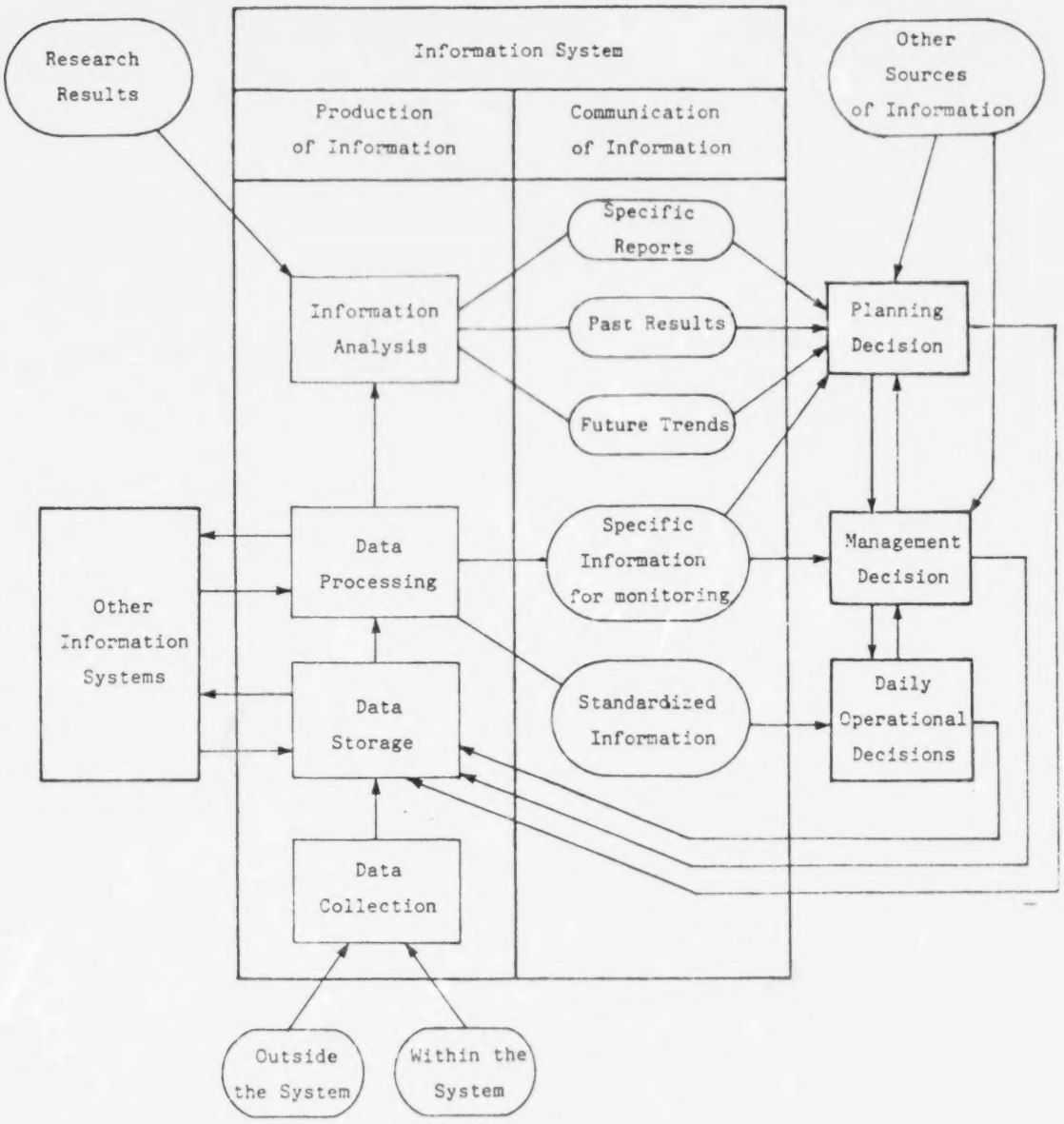


Figure 10: The main components of an information system

Since the number of institutions from which the data should be collected is very high, the only convenient way is to use a standardized questionnaire with all its limitations. The information collected is mainly quantitative. It covers only the external aspects of the educational process, i.e. the most apparent and the most easily measured ones. It can show deviations from the norms or deviations from the quantitative targets set but it does not allow to identify the real problems nor to monitor properly the system.

Often also, there is not a systematic effort to identify the information which are really needed and which can be used efficiently. Questionnaires may be updated every year, but they are very slightly changed and sometimes new data requirements are added. As a result a substantial amount of data is collected. Part of the information thus collected is not even processed and very little, in fact, is used for problem identification and decision-making.

In spite of these limitations, data collection constitutes a very heavy and cumbersome activity which requires a lot of time and effort from the statistical office of Ministries of Education. Since the r le of the Institutions or of the regional level of administration is to provide data, they do not know how the data will be used and to what extent they may influence decision-making. As a consequence, they are not really motivated and tend to look upon data collection as a routine, additional task. This may explain the lack of reliability of data.

Instead of having data being centrally processed, there may be advantages in having them regionally or locally done provided that the necessary facilities and competences exist:

- As we have seen, the need and the use of information are different at the local, regional and central level. Decentralization of data processing and analysis allow to cope better with the specific needs of each level of administration;

- Decentralization of processing permit also to save time particularly in so far as data entry is concerned. Raw or partially processed data can be communicated to the next level for further analysis and use;

- Having to process and use data, the local and regional levels may be more motivated to try to obtain more reliable data.

Information needed for planning, however, does not only concern the functioning of the educational system. Data have therefore to be collected outside the system and specific survey may have to be designed. One may think for instance of surveys conducted in enterprises in order to obtain information about recruitment policy or employment of graduates. This type of survey is, in general, rather costly and sampling techniques should be carefully used in order to minimize the cost while ensuring that the sample is representative and that the data collected can be analyzed and interpreted without any bias.

Data storage

When it is done manually, data compilation is a very time consuming operation. It is not error-free because of the number of manipulations to be made. Data retrieval also is not very convenient and cannot be done quickly. To improve access to information, data are summarized for instance in the form of statistical yearbook. Because of the lack of space the unit of analysis is rather large and data are presented in an aggregated form. This way

of storing data leads to a loss of information since what is kept and used is average. Yet, what is needed in order to identify possible problems is not average situation but the dispersion around the mean, i.e. disparities.

With existing computer facilities it is possible to store very large amount of information. Different software have been developed, some of them for micro computer, for the creation and management of Data base, making data retrieval very convenient, easy and quick. Data base can therefore be a very useful instrument for rapid access to information. From a technical point of view there is no major problem. There is the need, however, to conceive and to design carefully the data bases, taking into account the different needs of the various users. the four basic questions are:

- What are the data to be stored?
- How can these data be regularly updated?
- How can these data be used?
- How should these data be processed and presented?

Data processing

The way data should be processed depends of course upon the different categories of decisions. For operational decisions when the criteria for decision are clearly defined, where norms exist, where standardized procedures can be used, it is possible to develop specific applications. This is the case for instance for the organization of examinations and processing of examinations results, for different aspects of personnel management, for monitoring of expenditures and budgetary control.

But as we go from the operational decisions to the planning decisions the problem become much more complex both in terms of the identification of the information which might be relevant and the way it should be processed.

For analysis of past situation different 'statistical packages' exist allowing for the use of a large range of statistical analysis methods. For exploring future trends, precasting and simulation models may be developed for sensitivity analysis, for assessing long-term effects or for comparing alternative courses of action. The difficulty is, however, in the interpretation of results and in the choice or realistic assumptions for future trends.

Information analysis

Information analysis is undoubtedly the most important and at the same time the most difficult part of the use of information in decision-making.

For any planning issue, the range of information which may be relevant is extremely large. The information come from different sources, its degree of reliability varies. Yet on the basis of this set of heterogeneous information it is necessary to draw conclusion which are meaningful to decision-makers.

Information analysis for decision-making is very similar to research and may use the same approach and the same methodology with, however, two additional constraints:

- Time pressure because it is not possible to delay decision-making
- The need to arrive at conclusions which can be translated into course of actions.

These two constraints are at the basis of the misunderstanding between researchers and decision-makers and make their dialogue extremely difficult.

In many Planning Divisions of Ministry of Education, often research is given low priority. Research capacity and experience in research and in the use of research results are limited. That's why existing information or information which can easily be made available are not always efficiently used.

Obviously, the careful analysis of the multiple dimensions of a problem, the identification of all possible effects of a course of actions can be very helpful for decision-making. However, all the factors, which the decision-maker has to take into account are not necessarily included in the analysis. The criteria he uses, the weight he gives to each of them may be different. Finally, in the choice of alternative courses of actions the way he evaluates the relative importance of short-term effects as against long-term effects is not always the same as that of the analyst. This is again the source of many misunderstandings.

Lecture 11

Projection of qualified manpower needs: critical analysis of existing methods

by B. Sanyal

Objective of the session

During the previous session, the need for information on future requirements for qualified manpower has been emphasised to provide one of the bases for the planning of higher education. Some guidance is needed as to the direction that the development of education in general, and higher education in particular, should take in quantitative terms to cater for future needs for skills. It is believed that forecasting of qualified manpower can provide this guidance. Although methods of forecasting have a lot of limitations (this will be discussed later), an increasing number of countries, especially from the developing world, are preparing manpower forecasts according to occupational and educational requirements within the framework of their development plans. The present session has therefore, as its objectives:

(a) to apprise participants of the different methods of projection of qualified manpower; and

(b) to sensitize them about the shortcomings of these methods as regards their adaptation to specific contexts.

Different methods of projection of qualified manpower needs

A variety of methods have been used to derive manpower forecasts in different countries. The dominant model is known in the literature as the 'manpower requirements' method. The different steps of this particular model will be outlined and then discussed. The discussion will also be based on two earlier sessions entitled: 'Structure of the industrial sector' and 'Structure of qualified manpower within the industrial sector'.

We shall adopt the methodology used in the OECD's Mediterranean Regional Project (MRP). This is for two reasons: first, this project provides the most extended number of 'steps' in generating the manpower forecasts and, second, the MRP model (or some slight variant of it) is the one still used today by a great number of countries.[45]

The three major steps in qualified manpower forecasting are: (a) projecting the demand for educated manpower, (b) projecting the supply of educated manpower, and (c) balancing supply and demand. In what follows, we mainly consider the first step and its main stages, since we are dealing here with the manpower forecasts. Let us introduce the following symbols:

[45] Psacharopoulos G. and Debeauvais M. 'Forecasting the needs for qualified manpower: towards an evaluation' in Forecasting Skilled Manpower needs: The experience of eleven countries Edited by R.V. Youdi and K. Hinchliffe, Unesco, Paris 1985.

P = population
L = Labour force
X = output
i = economic sector
j = occupation
k = educational level (or type)
T = target year of the plan
0 = base year of the plan

A. The demand side

The MRP methodology uses five main steps in assessing the required number of workers by educational level in the target year of the plan. These are as follows:

Estimating the future level of output (X_T) for the target year

We know $\frac{X0}{P_0}$ = GDP per capita in the base year.

Let r_1 represent the desired average annual growth rate in GDP per capita and r_2 the estimated growth rate of population.

Then GDP per capita in the target year T will be

$$\frac{X0}{P_0}(1 + r_1)^T$$

and output in the target year will be

$$\frac{X0}{P_0}(1 + r_1)^T \times P_0 (1 + r_2)^T = X_0 (1 + r_1 + r_2 + r_1 r_2)^T = X_T$$

Estimating the structural transformation of the economy or the distribution of GDP by economic sector

$$\left(\frac{X_i}{X}\right)$$

According to the International Standard Industrial Classification of all Economic Activities (ISIC-1968), the major divisions of industries are:

i = 1. Agriculture, hunting, forestry and fishing
i = 2. Mining and quarrying
i = 3. Manufacturing
i = 4. Electricity, gas and water
i = 5. Construction
i = 6. Wholesale and retail trade, restaurants and hotels
i = 7. Transport, storage and communication
i = 8. Financing, insurance, real estate and business services
i = 9. Community, social and personal services
i = 10. Activities not adequately defined

(See the outline of the session 'Structure of the Industrial Sector').

In tabular form the structural distribution can be demonstrated as shown in Table 26 for the base year 0.

Table 26

Distribution of GDP by economic sector (base year)

Industry	GDP	GDP Share of total
Agriculture	$X_{1.0}$	$p_{1.0}$
Mining	$X_{2.0}$	$p_{2.0}$
Manufacturing	$X_{3.0}$	$p_{3.0}$
	.	.
	.	.
	.	.
Services	$X_{9.0}$	
Others	$X_{10.0}$	$p_{10.0}$
Total	X_0	1.0

Economic development, in particular, industrial development will change the share of different industries in the total GDP resulting in structural transformation of the economy.

The structural transformation will change the values of p_i ($i = 1, 2, \ldots 10$) depending upon the growth rates of each industry, which are often predetermined by policy.

$$p_{i.T} = \frac{X_{i(1+s_i)^T}}{X_T} = \frac{X_{i.T}}{X_T}$$

Where s_i is the average annual growth rate of the industry i.

Let us remember that $\sum_i p_{i.T} = 1$

and $\sum X_i \ (1+s_i)^T = X_T$

X_{iT} is target year contribution to GDP of the industry i, $i = 1,2,\ldots10$

This will result in Table 27 for the economic structure of the country in the target year T.

Table 27

Economic structure of the country in target year T

Industry	GDP at year T	Share of GDP
Agriculture	$X_{1.T}$	$p_{1.T}$
Mining	$X_{2.T}$	$p_{2.T}$
Manufacturing	$X_{3.T}$	$p_{3.T}$
	.	.
	.	.
	.	.
Services		
Others	$X_{10.T}$	$p_{10.T}$
Total	X_T	1.0

Estimating labour productivity by economic sector for target year and its change between base and target year

$$\left(\frac{X_i}{L_i}\right)$$

The productivity of labour for each sector is estimated from the GDP of each sector divided by the number of workers in that sector. For the base year, this can be represented in Table 28.

Due to changes in the technology, means of production and organization of work, labour productivity will change in varying degrees for the different sectors. These changes are estimated from (1) past trends or (2) model country productivities or (3) international comparison or (4) experts' judgement or (5) a combination of several of (1) to (4).

Let the productivity growth rate estimated as above for the sector i = u_i, then

$$q_{i.T.} = q_{i.0}\,(1 + u_i)^T$$

Where q_{iT} = productivity of the sector i in the target year T. This gives us Table 29 for the target year.

The overall labour productivity can then be estimated as: $q_T = X_T/L_T$

Estimating the occupational structure of the labour force within each of the economic sectors in the target year

$$\left(\frac{L_{ij}}{L_i}\right)$$

Table 28

Distribution of GDP by economic sector (Base year)

Industry	GDP	No. of workers	Labour productivity
i	X_i	L_i	X_i/L_i
Agriculture	X_1	L_1	$X_1/L_1 = q_{1.0}$
Mining	X_2	L_2	$X_2/L_2 = q_{2.0}$
Manufacturing	X_3	L_3	$X_3/L_3 = q_{3.0}$
	.	.	.
	.	.	.
Services	X_9	-	-
Others	x_{10}	L_{10}	$X_{10/L_{10}} = q_{10.0}$
Total	X_0	L_0	$X_0/L_0 = q_0$

Table 29

Labour productivity by economic sector (Target year)

Industry	GDP in year T	Productivity in year T	No. of workers in year T
Agriculture	$X_{1.T}$	$q_{1.T}$	$X_{1.T}/q_{1.T} = L_{1.T}$
Mining	$X_{2.T}$	$q_{2.T}$	$X_{2.T}/q_{2.T} = L_{2.T}$
Manufacturing	$X_{3.T}$	$q_{3.T}$	$X_{3.T}/q_{3.T} = L_{3.T}$
	.	.	
Services	$X_{9.T}$	$q_{9.T}$	$X_{9.T}/q_{9.T} = L_{9.T}$
Others	$X_{10.T}$	$q_{10.T}$	$X_{10.T}/q_{10.T} = L_{10.T}$
Total	X_T		L_T

The International Standard Classification of Occupations (ISCO-1968) gives the following *major groups of occupations*

j = 0/1: Professional, technical and related workers
j = 2 : Administrative and managerial workers
j = 3 : Clerical and related workers
j = 4 : Sales workers
j = 5 : Service workers
j = 6 : Agriculture, animal husbandry and forestry workers, fishermen and hunters
J = 7/8/9: Production and related workers, transport equipment operators and labourers, for convenience let j = 7 in our case
j = 10 : Workers not classifiable by occupation and members of the armed forces, for convenience let j = 8 in our case.

(See the outline of the session on 'Structure of Qualified Manpower')

First let us examine the occupational structure of the labour force within each economic sector for the base year. Within each sector we shall compute the proportion of each occupation listed above. (See Table 30).

Table 30

Labour force by occupation and economic sector (Base year)

Industry/ occupation	Professional	Administrative	Production	Others	Total
Agriculture	l_1	$l_{1.2}$	..	$l_{1.8}$	1.0
Mining	$l_{2.1}$	$l_{2.2}$	..	$l_{2.8}$	1.0
Services					
Others	$l_{10.1}$	$l_{10.2}$	..	$l_{10.8}$	1.0

Note that $l_{ij} = L_{ij/L_i}$ = proportion of labour force in sector i with occupation j.

i = 1, 2 .... 10; j = 1, 2 .... 8.

For the target year, the proportions will change because of changes in the economy, technological changes, changes in the means of production and in the organization of work, changes in the qualification level in the labour force, etc.

The method of incorporating these changes will be discussed later. For the time being, let us assume that: $l_{ijT} = a_{ij}\ l_{ij0}$ where l_{ij0} is the proportion of labour force with occupation j in the economic sector i for the base year and l_{ijT} is the same for the target year.

a_{ij} is the proportional change in l_{ij0}

$$aij > 0$$

For example, a_{ij} could be equal to $(1 + r_{ij})^T$, where r_{ij} is the growth rate in the proportion on average per year.

So we can have the target year labour force for each occupation within each economic sector once l_{ijT} values have been calculated because from Table 29, we already know the total labour force for each sector in the target year and $L_{ijT} = l_{ijT} \times L_{iT}$ where L_{ijT} is target year labour force in occupation j and sector i and L_{iT} total labour force in sector i in target year (see Table 31).

Table 31

Labour force by occupation and sector (Target year)

Industry/ Occupation	Professional	Administrative	Others	Total
Agriculture	$L_{11.T}$	$L_{1.2T}$	$L_{1.8T}$	$L_{1.T}$
Mining	$L_{2.1T}$	$L_{2.2T}$	$L_{2.8T}$	$L_{2.T}$
	.	.		
	.	.		
Services	.			
Others	$L_{10.1T}$	$L_{10.2T}$	$L_{10.8T}$	$L_{10.T}$
Total	$R_{1.T}$	$R_{2.T}$	R_{8T}	L_T

Note: R_{1T} = total no. of workers with occupation: professional, technical and related;

$$\sum_{j=1}^{8} R_{jT} = L_T = \sum_{i=1}^{10} L_{iT}$$

This leads us to the final step:

Estimating the educational structure of the labour force in given occupations within economic sectors in target year

$$\left(\frac{L_{ijk}}{L_{ij}}\right)$$

As before, this is also done on the basis of the base year observations. First the educational levels and types (k) are determined and the number of workers with different levels and types of education within each occupation are noted. The proportion of each level and type of education within each occupation is computed. This proportion is the basis for future projection. The base year values of proportions (e_{jk}) can be demonstrated in Table 32.

Table 32

Proportion of graduates in different occupations by level and type of education (Base year)

Occupation/ Education	Regular			Adult			
	Post-graduate	Graduate	Short-Cycle	Graduate	Short-Cycle	Others	Total
Professional	e_{11}	e_{12}	e_{13}	e_{14}	e_{15}	e_{16}	1.0
Administrative	e_{21}	e_{22}	e_{23}	...	....	e_{26}	1.0
Agricultural workers	.						
Production & related	.						
Services	.						
Others	e_{81}	e_{82}	e_{83}	..	...	e_{86}	1.0

Note that we are mainly concerned with higher education.

The changes in these proportions are also determined for the target year in the same way as the changes in the occupational structure.

Let us assume that $e_{jkT} = a_{jk}\, e_{jk0}$

In a particular case we may have $a_{jk} = (1 + r_{jk})T$ where r_{jk} is the average annual growth rate in the proportion of labour force with education k within occupation j. e_{jkT} = proportion of labour force for the same in target year (T) and e_{jk0} is the same for the base year a_{jk} is the change in the proportion e_{jk0} for education j and occupation k. Since we know the total number of workers for each occupation in the target year, we can easily obtain the total number of workers for each type of education in that occupation by multiplying the total number of workers by e_{jkT}

For example, to get the number of professionals needed with post-graduate degree (E_{11T}) we have to simply multiply R_{1T} by e_{11T} (see Table 32) or in general $E_{jkT} = R_{jT}\, e_{jkT}$, j = 1, 2 ... 8; k = 1, 2 ... 6. This gives us Table 33.

F_{1T} = Total no. of workers with post graduate education

Table 33

No. of graduates needed for the different occupations by level and type of education (Target year)

Occupation/ Education	Post-graduate	Graduate	Short-cycle	Graduate	Short-cycle	Others	Total
Professional	$E_{1.1.T}$	$E_{1.2.T}$	$E_{1.3.T}$	$E_{1.4.T}$	$E_{1.5.T}$	$E_{1.6.T.}$	$E_{1.T.}=R_{1.T}$
Administrative	$E_{2.1.T}$				$E_{2.6.T}$		$E_{2.T}=R_{2.T}$
Agriculturists							
Production							
Others	$E_{8.1.T}$					$E_{8.6.T}$	$E_{8.T}=R_{8.T}$
Total	$F_{1.T}$	$F_{2.T}$	$F_{3.T}$	$F_{4.T}$	$F_{5.T}$	$F_{6.T}$	L_T

F_{1T} = Total no. of workers with post graduate education

$$\sum_{k=1}^{6} F_{kT} = L_T = \text{Total no. of workers}$$

F_{kT} = Total no. of graduates required for the year T with education k to achieve the economic growth rate envisaged in our forecasts, based on the assumptions given above.

It should be noted that steps (1) to (3) pertain to general economic planning. Our concern as educational planners will be the last two steps which deal with occupational and educational forecasting. As indicated above, we shall give the different methods of forecasting the occupational structure from $(L_j)0$ to $(L_j)T$ below.

Several alternative ways have been used in different countries in their attempts to forecast the occupational structure:

(1) *International models*, i.e., to observe the occupational structure of a country at a more advanced level of development and hypothesize that this is the desired structure in the country where the forecast is being made.

This may consist in the use of Model country comparisons, for example, Puerto-Rico utilized the coefficients of the United States, and Italy those of France.

It may also be Group country comparisons such as the use of parameters estimated from many OECD countries.

(2) *Model firm comparisons*, i.e., to observe the occupational structure of the most modern or efficient firms and stipulate that their occupational structure can be adopted for the plan.

In the socialist countries, for instance, the 'model firm' is taken to be the one using the latest technology.

(3) *Staffing norms*, i.e., to follow the advice of experts or simply intuitive insight of the planner and specify certain desired ratios of engineers-to-technicians, doctors-to-nurses, and so on.

This technique is often used in the agricultural sector in general and in the socialist countries.

(4) *Time series extrapolation*, to predict the occupational structure simply as a function of time following past trends.

$$\frac{L_{ij}}{L_i} = f(t)$$

This method has been used extensively in French planning.

In most cases, more than one of these methods is used depending on the economic activity being analyzed, as mentioned earlier.

It should be noted that changes in the occupational structure due to changes in the economy, especially technological changes, are to be taken into consideration at this stage.

Forecasting the educational structure

There exist, in general, two distinct classes of methods for expressing the forecast in educational terms: those working from occupation to education, and those which by-pass the occupational dimension and produce directly the forecast in terms of education. We have considered above the first class of methods.

The educational content of given occupations is found according to a typical, idealized structure (methods followed by French planners). It could also follow the international model, group country comparison or model country comparison method described above.

It should be noted here that possible substitution between education and occupation can be taken into account at this stage.

By-passing the occupational forecast

In this case, the educational structure is derived as a direct function of labour productivity, i.e.

$$\frac{L_k}{L} = f\left(\frac{X}{L}\right)$$

or from a more general production function where a labour utilization coefficient (b) links output to educated labour,i.e.

$$L_k = bY$$

B. The supply side

A distinction should be made between spontaneous supply of educated labour as a result of social demand, and the planned supply of educated labour that is a result of policy. The supply side here under (B) refers to the non-planned creation of educated labour, whereas the next heading (C) will deal with policy adjustments.

More detailed methods of supply projections will be described in another session. Briefly, the supply projections involve three basic steps:

(1) Making population projections by school age groups . These projections take place according to any standard demographical model or, in certain cases, they are simple time extrapolations;

(2) Assessing the number of graduates by educational level and type . This follows the social demand model, namely school level transition probabilities are applied to the base population cohorts. These are followed through time until they exit the educational system, formal or non-formal.

(3) Determining the labour force participants . This is achieved by applying the sex-age-educational level specific labour force participation rates to the graduates generated in the previous step.[46]

C. Balancing supply to demand

It is very unlikely that the demand for qualified manpower generated in part (A) matches exactly the spontaneous supply assessed in (B). It is for this reason that a final exercise has to be undertaken, that is the adjustment to equate both sides, supply and demand.

1. Revising the demand and/or supply projections

This is usually done in two simultaneous ways that are not mutually exclusive.

If (Ejk) as estimated from the demand side is very different from the (Ejk) assessed from the supply side, the manpower planner will most likely go back to his computations and revise some of the assumptions used in (A) or in (B).

It might be realized, for example, that, the productivity coefficients used for future labour on the demand side were too *optimistic.* Or else, for instance, the participation ratio adopted regarding the labour force on the supply side was too pessimistic . Several other assumptions could be re-examined in light of certain factors. By selecting other parameters than those assumed originally the planner can reconcile a great deal of the discrepancy between future supply of and demand for qualified manpower.

2. Formulating the final plan

This step is the only genuine policy action for identifying manpower surpluses or deficits not likely to be covered automatically by spontaneous supply and then arranging for the output of educational programmes to equal supply and demand at the target year of the plan. The output has also to be phased year by year up to the target year. The policy of intake is to be based on these output figures, taking into account failure, drop-out and

[46] The details of the supply side will be analyzed in the next session.

repetition parameters and other losses and additions.

The supply of educated manpower may also be balanced with demand by computing the required output for each level and type of education adjusting for losses and additions. The intake to each level and type is to be computed from the required output, taking account of failures, drop-outs and repetitions. The total intake for each level and type is then to be distributed for each year among the institutions.

3. Other methods of projecting qualified manpower needs

(a) Tinbergen model: this is one variation of the MRP model. It bypasses occupational forecasts, neglects primary education enrolments and goes straight to estimating educational requirements, giving special attention to the required number of teachers, delineating the path of enrolments from the base year to the target year. It also pays special attention to the replacement of expatriates by national qualified manpower.[47]

(b) Saturation norms method: saturation norms are ratios of qualified manpower to the total labour force or total production. These norms are established for different groups of enterprises and for different types of qualified manpower. When the total labour force or total output of production in the future is estimated, the number of qualified manpower needed can be determined.

(c) Personnel nomenclature method: the nomenclature is a list of posts to be filled by qualified manpower. It is drawn up by means of expert analysis of each sector of the economy, group of enterprises or even a single enterprise, for the target year based on an analysis of the existing situation and future means of production of goods and services. The coefficients of qualification structure for each sector, group of enterprises or single enterprise (ratio of specialists with higher education to those with specialized secondary education, for example) are used to determine the number and type of qualified manpower which will be necessary.[48]

In addition there are several other methods of projecting qualified manpower needs, namely, the input-output model, linear programming model, social demand model, labour absorption model, etc. These, however, do not have much practical application. (For details one may read the works referred to in the article by G. Psacharopoulos and M. Debeauvais cited earlier).

Problems encountered in projecting qualified manpower needs

The problems arise principally from the assumptions incorporated in the methods when they are put into practice. These are:

(a) The occupational distribution in an economic sector is not as rigid in practice as is assumed in the MRP method. Inter-occupational substitution occurs, generally due to economic changes, but especially due to technological changes, making the

[47] Tinbergen J. and Bos H.C. 'A planning model for the educational requirements of economic development' in Econometric Models of Education, Paris, OECD, 1965.

[48] Ivanov I.V. 'Skilled manpower planning, forecasting and training in the USSR' in R.V. Youdi and K. Hinchliffe, op. cit.

projection inaccurate.

(b) The educational distribution of the labour force for an occupation is also not as rigid in practice as is assumed in the MRP method. Substitution of a level and type of education within an occupation by another level and type does take place, further contributing to inaccuracy of the projection.

(c) In countries where the educational system is extremely diverse, as is the case of China, it becomes difficult to relate the level and type of education to an occupation.

(d) Depending on wages, prices and availability, enterprises produce given amounts of output with widely varying mixes of labour and machinery, making any forecasting of manpower extremely difficult.

(e) Uncertainties about the economic growth of each sector, productivity changes, variation in the participation rates of the labour force and in the educational system, mobility of manpower, etc., especially when forecasts made relate to a long time period (as in the case of qualified manpower needs), make the task of projection extremely difficult.

(f) In the saturation and personnel nomenclature methods, the total labour force or the total output are often over-estimated in practice because of extensive and intensive involvement of the enterprises and the influence they exert on the estimations which is often subjective. The norms applied for determining the different types of qualified manpower are also subject to bias of the experts. Objective analysis is often impossible.

Finally, the available projection methods have not been able to take into account the rural-urban imbalance in manpower distribution and the costs of executing a manpower plan.

In spite of the above defects, these methods do provide some indication as to the direction higher education should take, especially when a country is committed to modernization. With an improved information base, some of the defects can be rectified, although economic uncertainties will always exist. New methods of projection are expected to be developed using an information base which will provide signals for steering the development of education, which will have a continuous monitoring, feedback and control system, as has been indicated in the session on building a data base for higher education planning.

Lecture 12

Projection of new admission and enrolment in relation with manpower needs

by Chu Siaoky

Objective of the analysis

As discussed in Lecture 11, methods of projection of qualified manpower needs are mostly based on the principle of matching the manpower demand coming from the productive sectors with the capacity of supply of the education system, and in particular of higher education. While the previous emphasis was on the assessment of demand, we shall focus this session on aspects of supply. Discussions will therefore be centred around different approaches to the projection of enrolment and new admissions in higher education, so that the resulting output of qualified manpower will meet the needs of industrial production.

This will also be a logical sequel to the trends and patterns identified in earlier sessions, by looking into the future orientations of the development of higher education. Some of the basic methodological parameters for effecting reliable and realistic projections are included below.

Basic approaches

The matching of manpower demand and supply, in particular in the context of higher education, can be tackled through the combination of two approaches.

The first approach is based on the structure and level of activity of the current education system, and of its past evolution, by taking into account the various structural and resource constraints. It is therefore a kind of upward analysis in which one has to consider the overall structure and balance between the different levels of education, and the transition of students from one stage to another.

Concretely speaking, this would mean for higher education that assessment will first have to be made of the level of output from secondary education, as well as of the rate of transition of the secondary graduates into higher education as new admissions. Based on the size of new admissions, that of enrolment could be established. Then, the number of graduates for future years can be estimated.

In practice, figures for new admissions were established by field of study according to two criteria: past trends in the distribution by field; and policy guidelines. This leads to the second method, which adopts a downward approach whereby policy guidelines for new admissions are set by translating projected qualified manpower needs into number of specialized graduates to be trained. This in turn gives estimates of enrolment and new admission by field of study.

The above summarizes the basics of the methodology in integrated manpower and educational planning.

Rates, ratios and proportions

One of the simplest methods for enrolment projection is the extension of past growth rate. Table 34 below presents a typical example of the application of this method.

Table 34

Enrolment projection calculated on past growth rate extension

Year	Total enrolment all fields	Enrolment in finance & economics	Annual rate of growth	% share of fin. & econ.	Annual rate of growth
1976	564 715	6 569	1.2		
1977	625 319	7 992	21.7	1.3	8.3
1978	856 322	18 190	127.6	2.1	61.5
1979	1 019 950	21 597	18.7	2.1	0.0
1980	1 143 712	37 082	71	3.3	57.1
1981	1 279 472	47 895	29.2	3.7	12.1
1982	1 153 954	55 980	16.9	4.7	27.0
1983	1 206 823	71 100	27.0	5.9	25.5

Source: Achievement of education in China - Statistics 1949-83.

It is therefore shown that enrolment in finance and economics has been growing at a very fast rate since 1976, to the extent that enrolment almost increased ten-fold during this short period of seven years.

If one can assume that this trend will continue in the near future, then the past rate of growth may be applied in projections of future enrolment. To do so, one way will be to use the latest rate of growth, or the average annual rate, or better still to study the trend in the rates of growth to determine whether it will decrease or increase, and by how much, in the future.

The above method is appropriate when there is a clear and stable trend in the annual growth rates. It was found, however, that this was not exactly the case. A second indirect way to approximate likely futures will be to base on the percentage share of finance and economics in the total enrolment. This is done by first of all projecting future percentage shares through the same procedure by making use of the annual growth rates in the last column of Table 34, and then multiply the projected percentage share to the projected total enrolment.

The essence of this method lies therefore in the combined use of direct and indirect projections of both the absolute figures as well as derived statistics such as rates, ratios and proportions which are relatively more stable in nature. Such combinations will ensure greater reliability of the final forecasts, by providing alternatives choices and at the same time enabling cross-checking of projection results.

A crucial aspect of the projection of enrolment and new admissions is the establishment of the relationships between enrolment, new admissions and graduates, according to fields and sub-fields of study. This will make it possible for us to estimate respectively the enrolment and new admissions required if given the number of graduates needed, or vice versa. Furthermore, established relationship between enrolment and new admissions may also enable us to verify the estimations obtained. This shows the usefulness of the triangular relationships among the three components.

Ratios such as new admissions as percentage of enrolment, graduates in ratio to the number of new admissions four years ago, or graduates as percentage of the enrolment two years ago, are therefore calculated and illustrated in Charts I, II and III (see Annex to this paper) for the past year. It should be mentioned here that the time lags given above for the relationships of graduates to enrolment and new admissions are based mainly on the general average time needed for graduation. In practice, different time lags may be applied to specific fields of study, such as teacher training, medicine and others.

It can be immediately observed in all these charts that despite wide fluctuations and interruptions during the period from 1967 to 1976, the overall ratios for all fields of study, as represented by the line joining together the square symbols, hovered around fixed levels. The ratio of graduates to enrolment two years back varied between 20 and 30 per cent. That to new admissions four years ago was centred around the 100 per cent level. And new admissions to enrolment have been fluctuating around 35-40 per cent. Similar ratios should be established in the same manner by field and sub-field of study, while taking into consideration the average duration of study.

Curve fitting

One has thus been able to identify patterns in the ratios above, despite their wide fluctuations over the years. This was in part facilitated by the straight line in each chart that runs across the curve. This straight line indicates the overall trend. It was obtained by applying linear regression techniques to the series of ratios over time.

Thus, the general trend of graduates as percentage of enrolment is shown to be on the increase, from barely over 21 per cent around 1952 to almost 30 per cent in 1983. The same applies to the other two ratios, for which the upward trends have been confirmed. But at the same time, one should also keep in mind that these ratios all have upper limits, namely that the number of graduates are only exceptionally more than the new admissions four years ago, and new admissions can rarely be near to 100 per cent of the total enrolment, which may occur during the foundation of a new institution.

The ratios have also demonstrated the existence of certain casual relationships between the three components: new admissions, enrolment, and graduates. But these relationships are not clear enough except for the general linear trends shown in Charts I, II and III.

A different approach has been adopted to show the relationships by representing the one-to-one correspondences for successive years, in a type of graphical presentation called the X-Y graphs. The square symbols in Charts IV, V and VI in the Annex show the correspondences between respectively graduates and enrolment two years back, graduates and new admissions four years ago, and new admissions and enrolment for the same years.

The dispersion of the square symbols in these charts again revealed certain patterns and concentrations, with the points mostly found along the diagonals from bottom-left to upper-right. Linear regression analysis is then applied to find the straight line that best fits each of the relationships. And they are shown in the charts.

The charts can be used in such a manner that when as a result of projections of qualified manpower needs there is the need for 200,000 graduates to be produced in the year 1990. By finding in Charts IV and V the projections onto the X-axis of the intersection of the horizontal line representing this level of graduates with the trends, it can be found that about 830,000 students will have to be enrolled in 1988 and around 230,000 new admissions in 1986. The cross-checking of the two latter figures against each other using the trend in Chart VI further confirms this correspondence.

Regression methods are therefore immensely useful in the identification of trends and projections. Besides, such methods are not limited to the fitting of straight lines to dispersions, which belongs to the category of linear models. There is also the non-linear approach which in some situations may derive better results.

Enrolment in finance and economics since 1976 that was given in Table 34 are represented in Chart VII by means of the square symbols. It was found that these points do not follow a linear dispersion. Attempts were therefore made to fit other types of curves to them, and finally the best fit was obtained by using an exponential curve of the type:

$$y = ae^{bx}$$

The degree of fit, in regression analysis, is measured by the coefficient of determination, abbreviated as R^2, which is usually produced as resulting statistics of regression. The principle is that the closer the value of the coefficient is to 1, the better the fit. Thus, a curve with a R^2 of 0.9876 fits better than one with 0.6545.

Flow-model

Projections by flow model based on the apparent or reconstructed cohort methods are often done for enrolment in primary and secondary education. These methods can also be applied to projections in higher education, with a few modifications.

First of all, separate flow models will have to be built and used for different fields and sub-fields of study, different sub-levels in higher education, different types of programmes and courses, and for different institutions or even faculties. The results obtained may then be collated to give the aggregates. This is a direct consequence of the diversities in higher education.

Secondly, admission can no longer be reliably based on the corresponding age-group population, as the extent of under- and over-age enrolment is much wider than in primary and secondary education. Higher education being the third stage in the formal educational process that requires as condition for access to it the successful completion of the previous two stages, the eligible population will be restricted to those who have graduated from senior secondary schools (Chart VIII), or equivalent secondary technical/vocational schools. Of course, non-formal higher education for the adults has less stringent admissions requirements, which only complicates further the identification of the base population.

A third aspect in the applications of flow models is difficulties in the fixing of rates of new admission. Very often the size of admission to certain fields are based on quotas fixed by policy guidelines. It is not determined according to the size of the clientele population. Furthermore, it is common practice that a candidate will apply for studies in different fields in different institutions, and little can be done to isolate the part of the clientele population that is specifically reserved for studies in a certain field.

The frequency of transfers, between fields of study, institutions and provinces, will have to be taken into account in the identification of patterns in the drop-in and drop-out rates for different years of study in the model. One has also to be very careful in making assumptions on possible future trends of these rates.

In relation to qualified manpower needs, there is the problem of the determination of the proportion of graduates who can be absorbed immediately in economically productive activities instead of pursuing further studies. The same problem arises with the clientele population consisting mainly of secondary school graduates. These are some of the aspects that will need to be taken into consideration in the application of the student flow models.

Overall projections

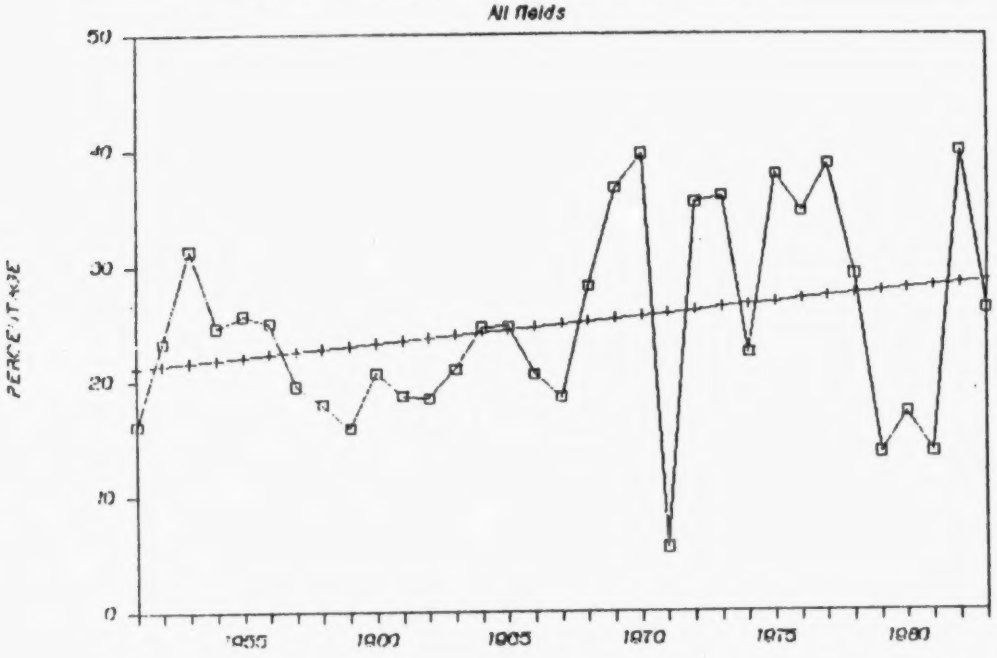
Past progress in enrolment, new admissions and graduates of higher education in China has been characterized by vast fluctuations that rendered the identification of clear trends extremely difficult. This was discussed in earlier sessions.

Attempts were nevertheless made to derive projections, or rather approximations. These are illustrated in Charts IX to XX, where different approaches to the fitting of curves to the past data series, and then to project to the year 2000, are shown. The results have not been very convincing as far as the general trends for all field of study are concerned. Some interesting findings may eventually be obtained in specific fields.

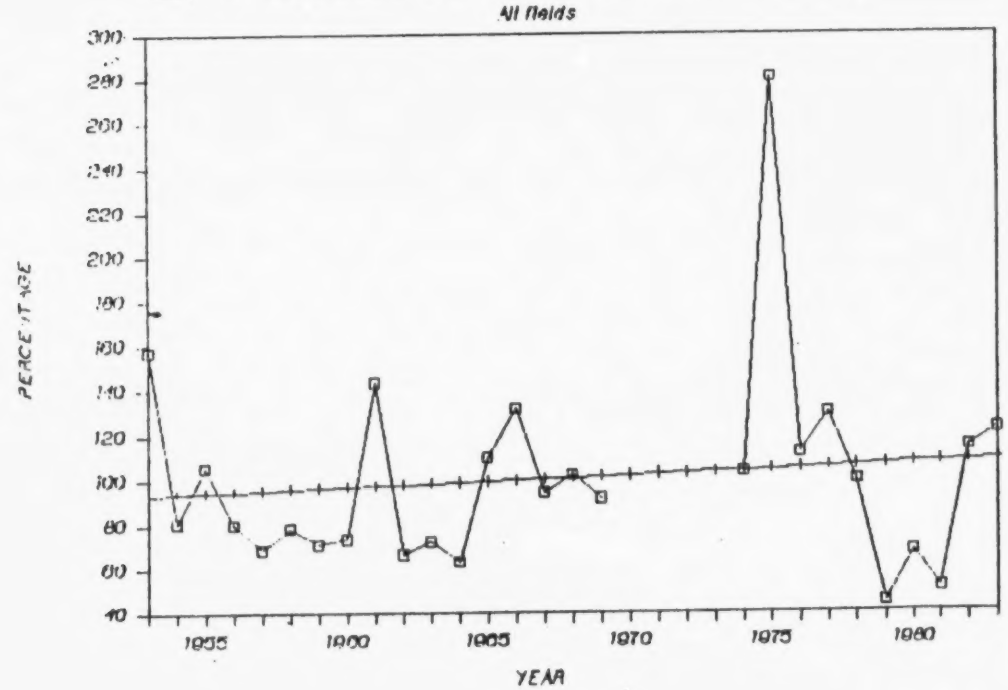
A major reason for throwing doubts on these regression projections is the downward trend in secondary enrolment and graduates shown in Chart VIII. As this trend is likely to continue as a result of reducing birth rate in China, the further sustained growth of higher education, or at least in the formal sense, is being questioned. This constraint applies not only to the approach by curve fitting. It is equally valid in the cases of flow models as well as downward projections based on manpower requirement projections.

This may have set the point of departure for renewed thinking on manpower planning for the future.

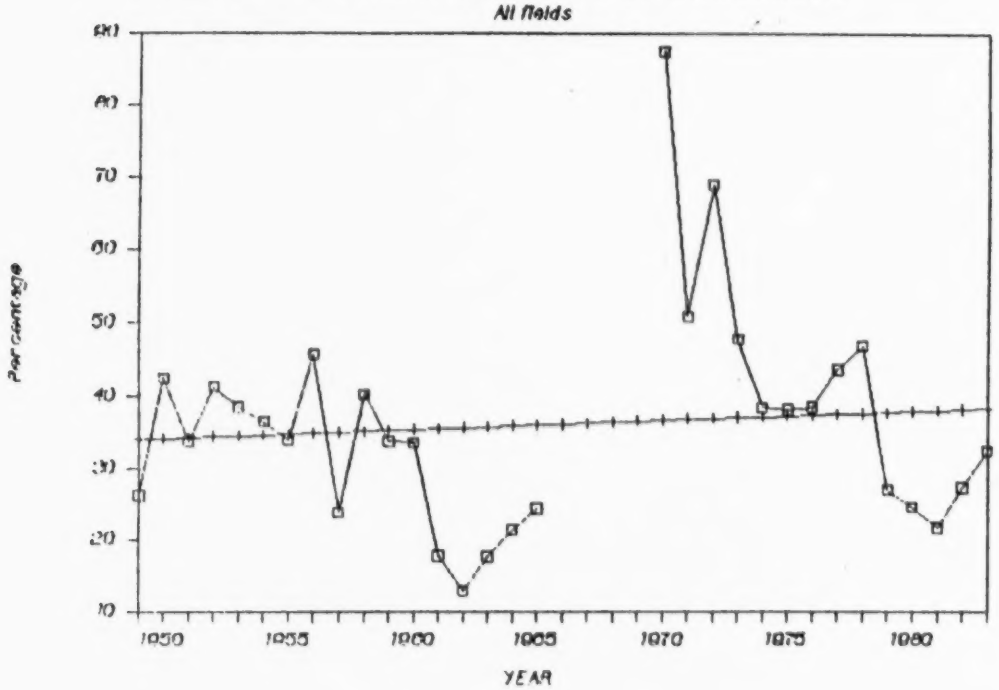
I. Graduates as % of enrolment



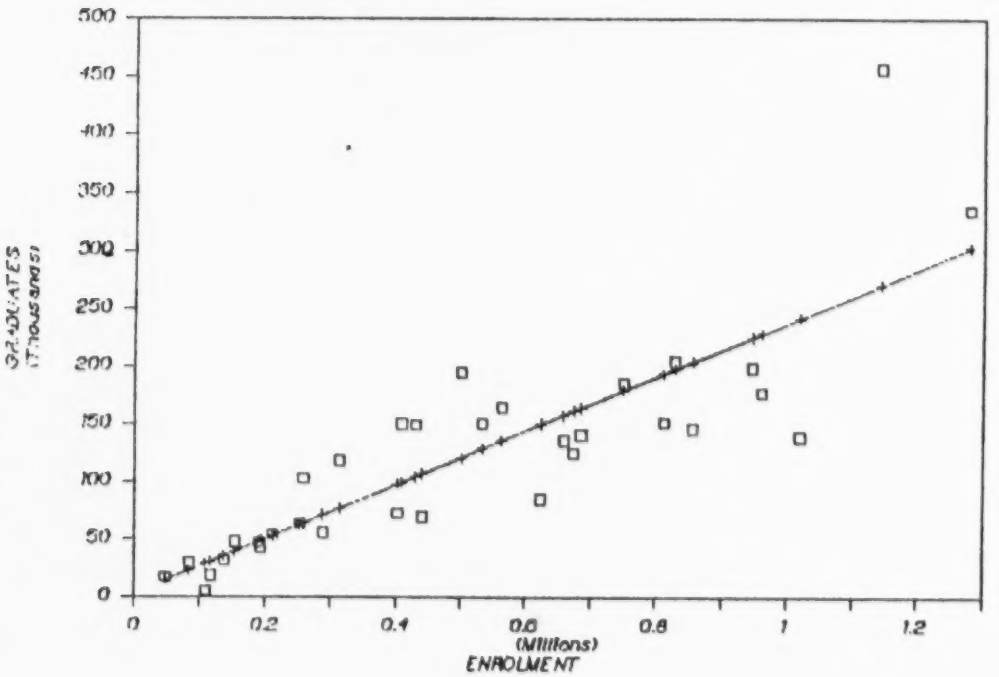
II. Graduates as % of new admissions



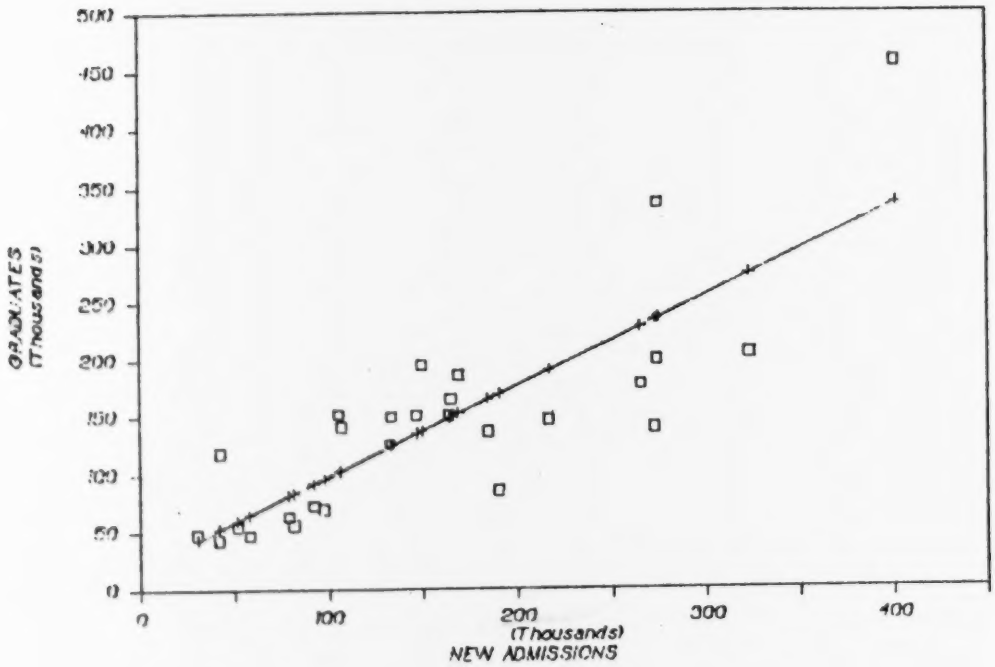
III. New admissions as % of enrolment



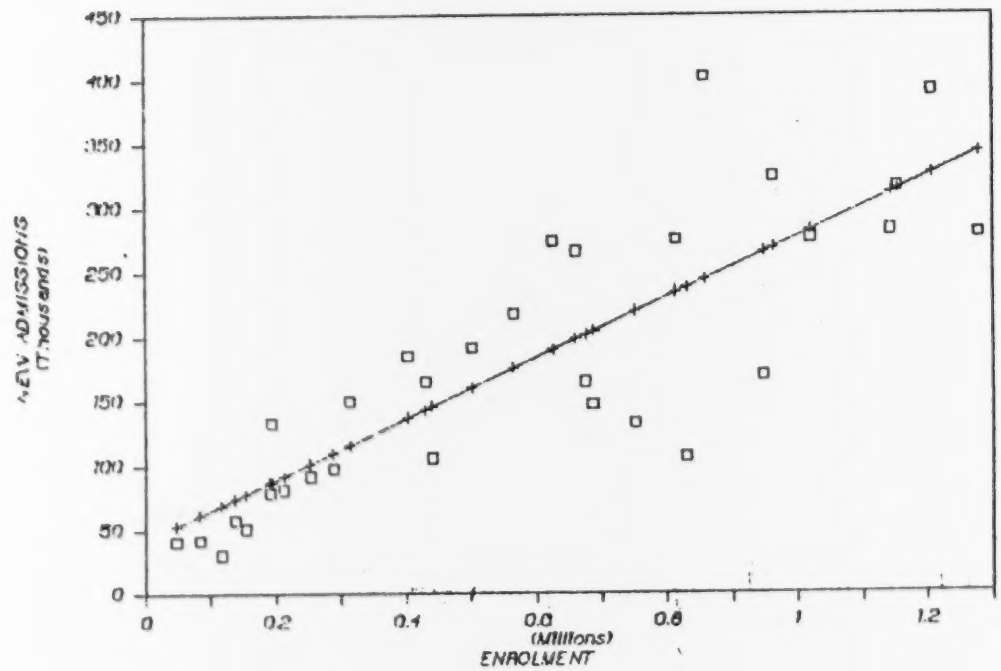
IV. GRADUATES – ENROLMENT



V. GRADUATES – NEW ADMISSIONS

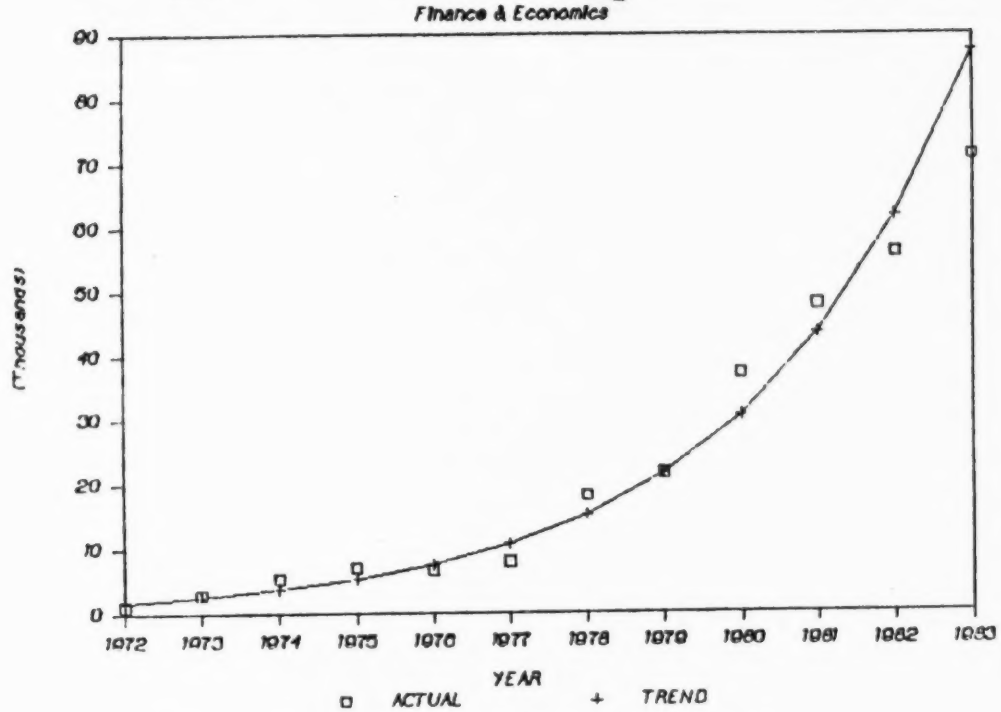


VII New admissions – Enrolment



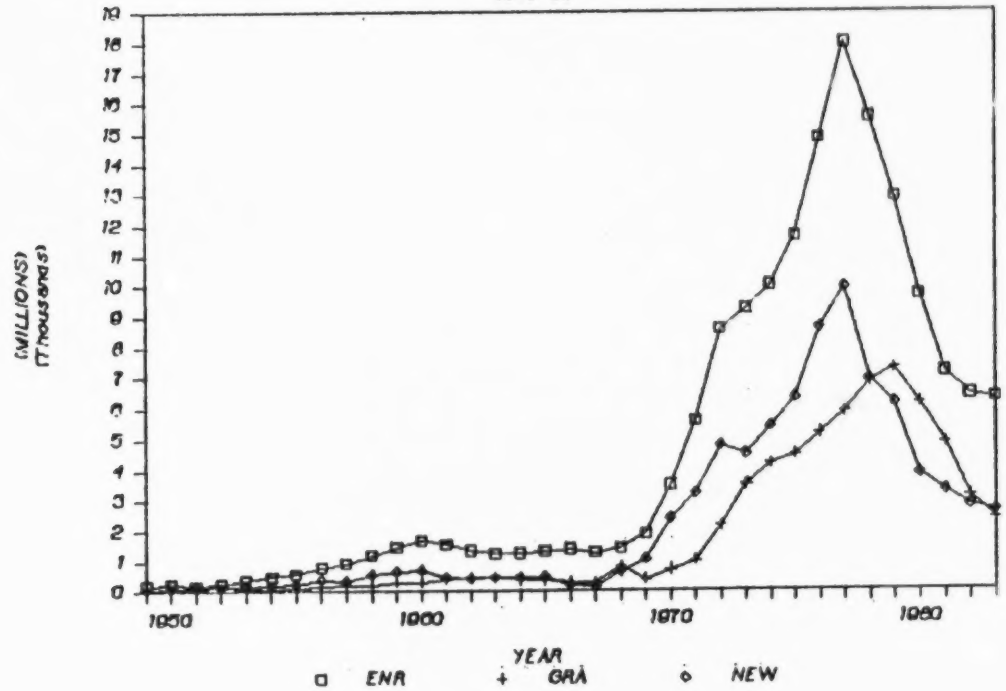
VII. Curve Fitting

Finance & Economics

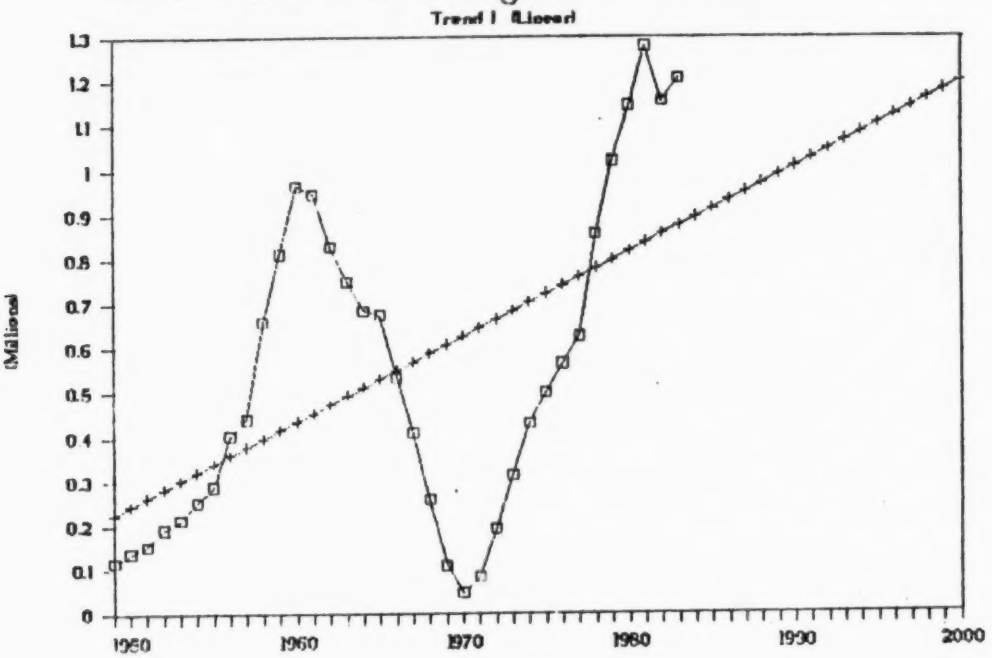


VIII. Senior Secondary Students

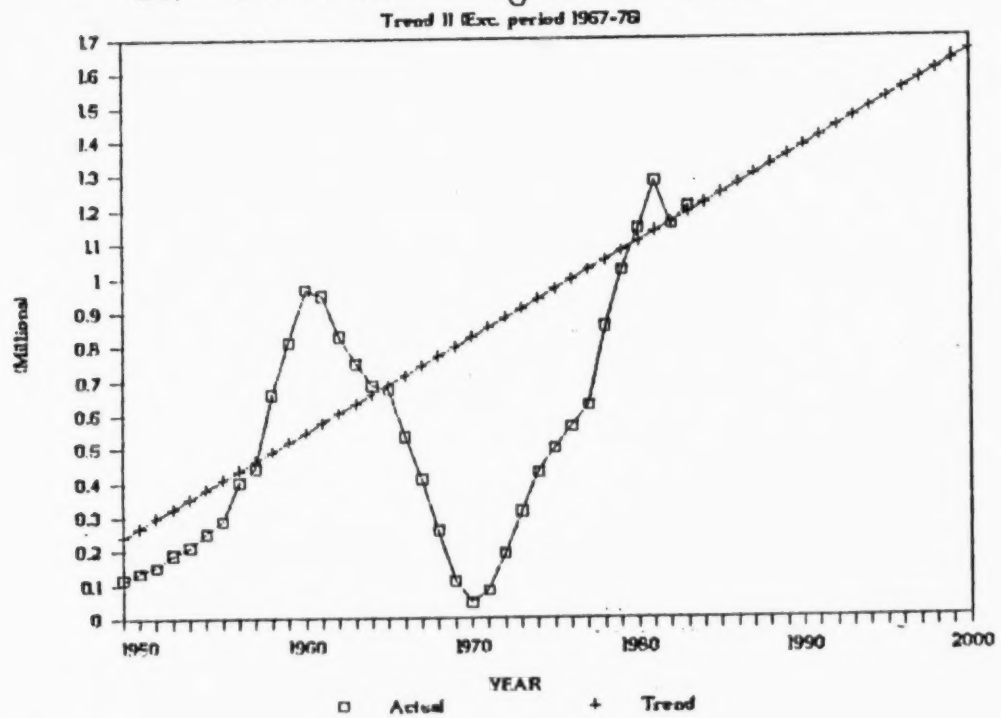
1949–83



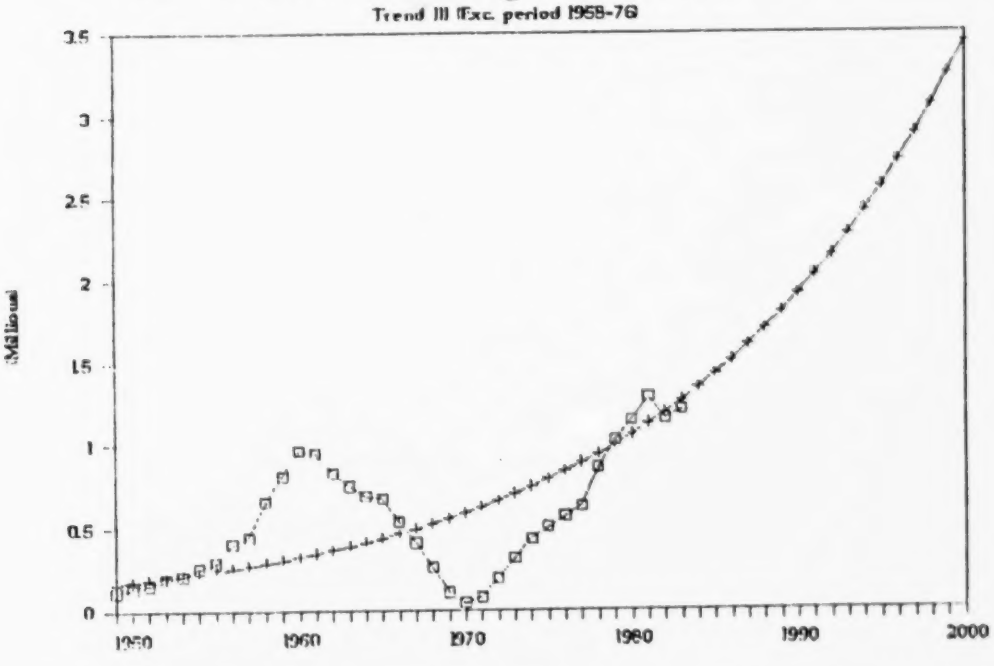
IX. Enrolment in Higher Education



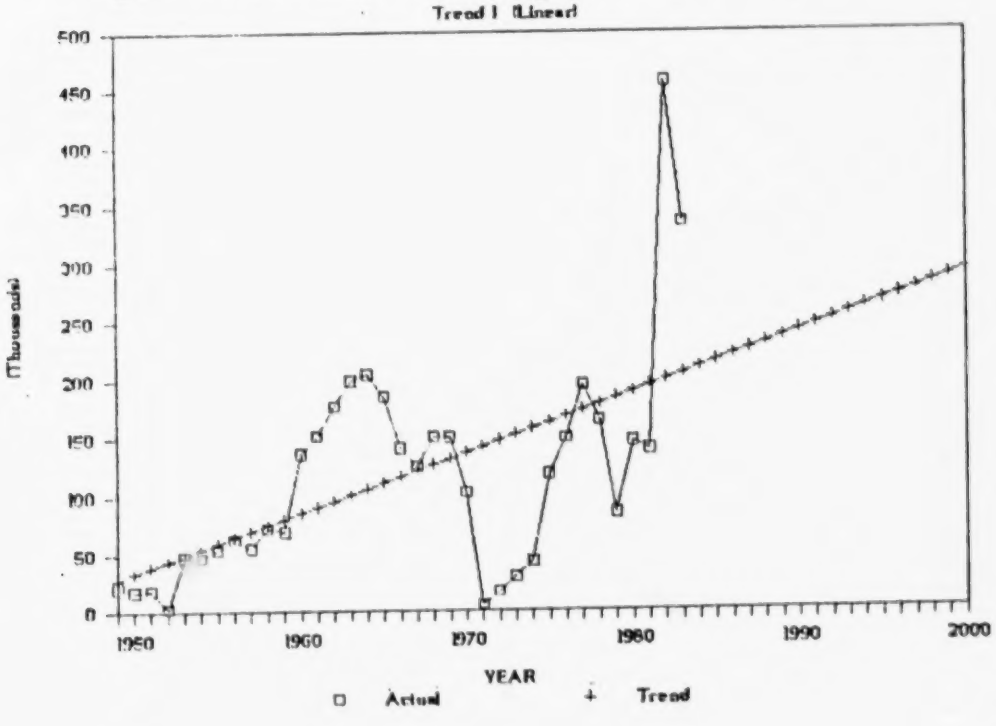
X. Enrolment in Higher Education



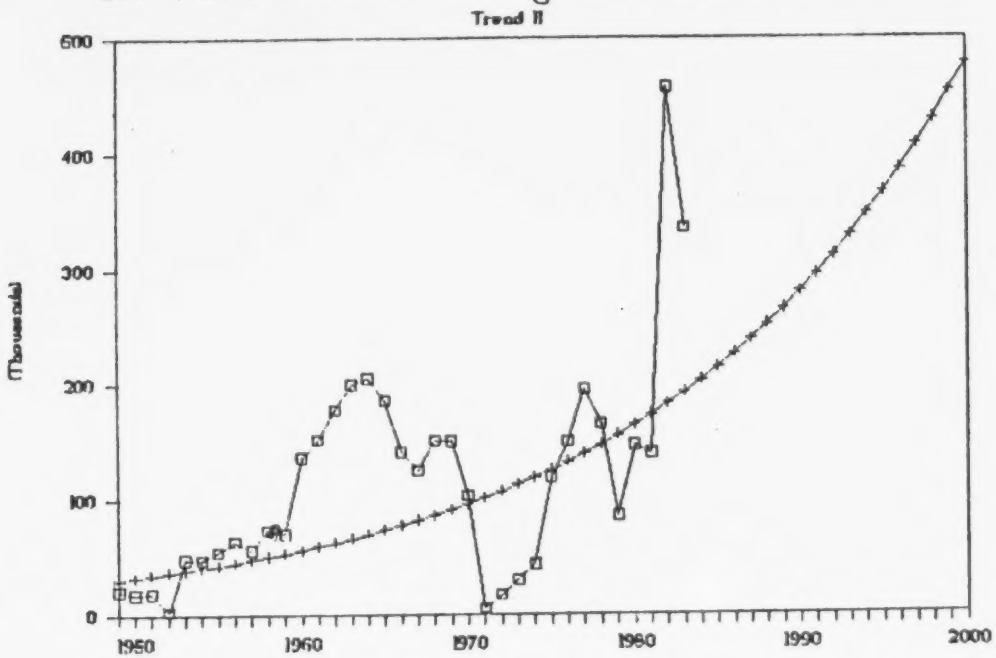
XI Enrolment in Higher Education



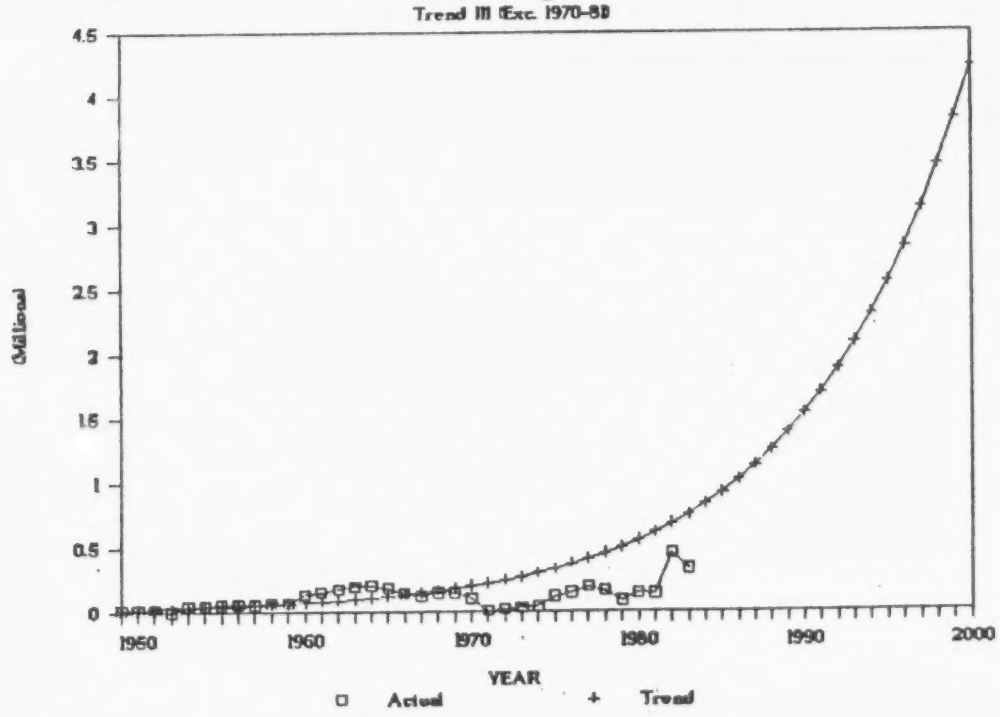
XII Graduates from Higher Education



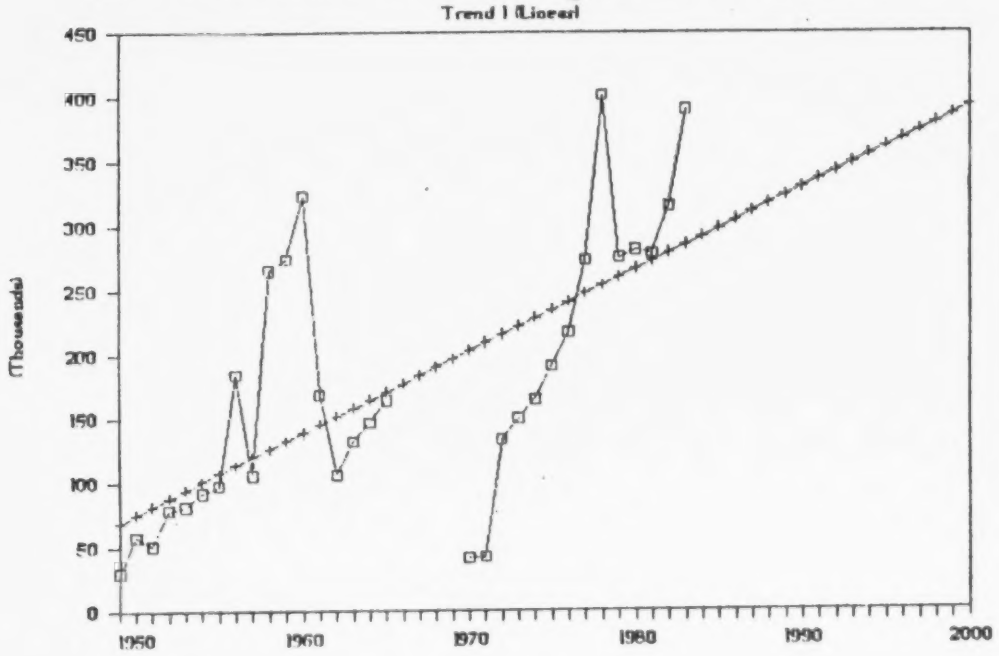
XIII Graduates from Higher Education



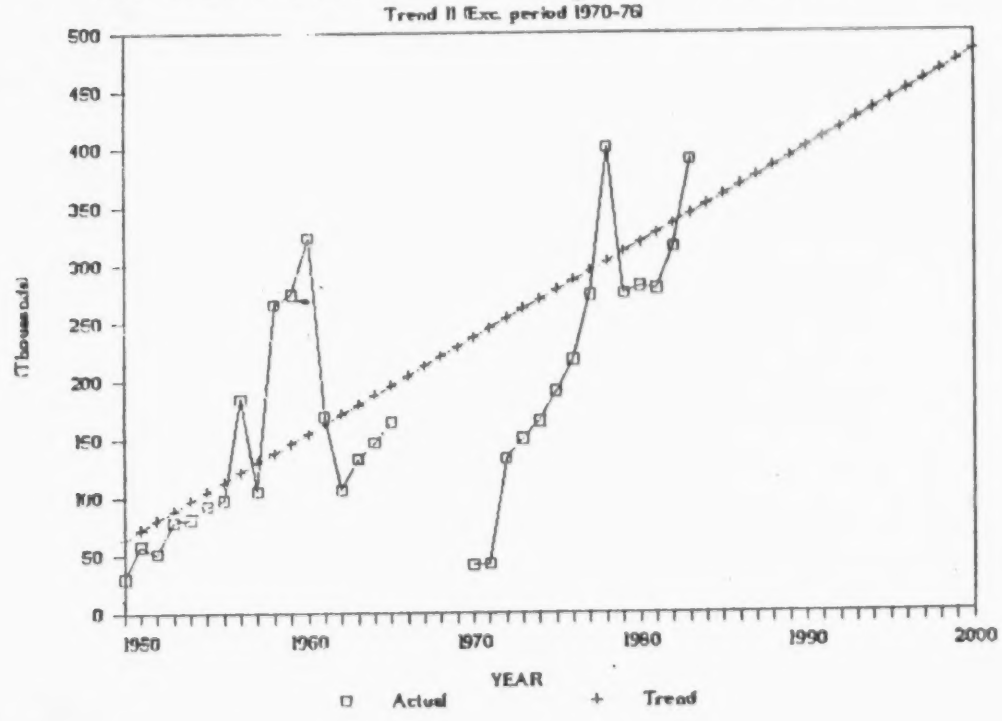
XIV Graduates from Higher Education



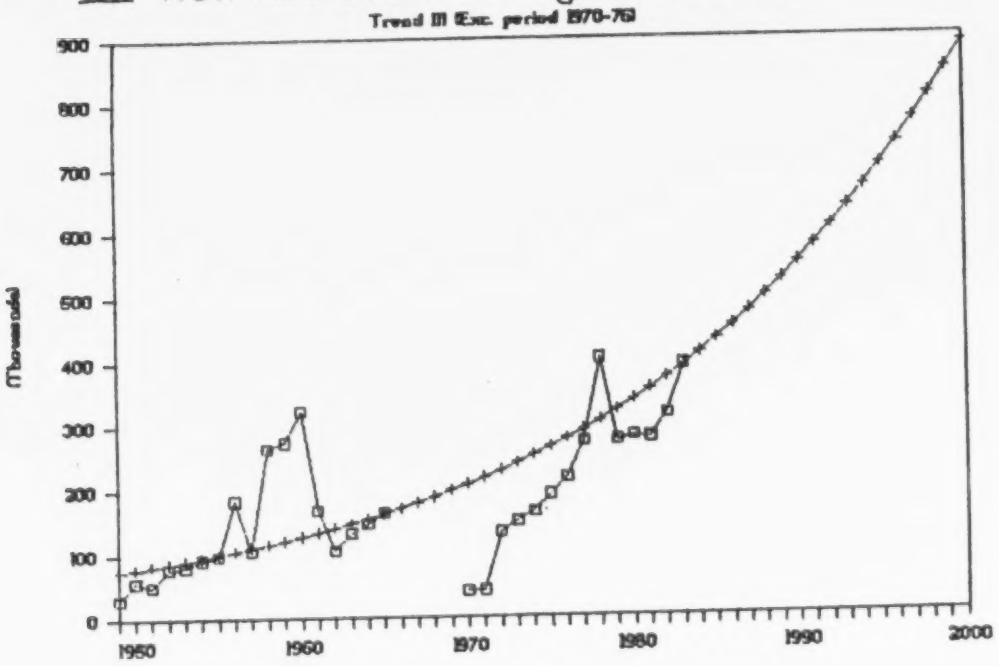
XV New Admissions to Higher Education



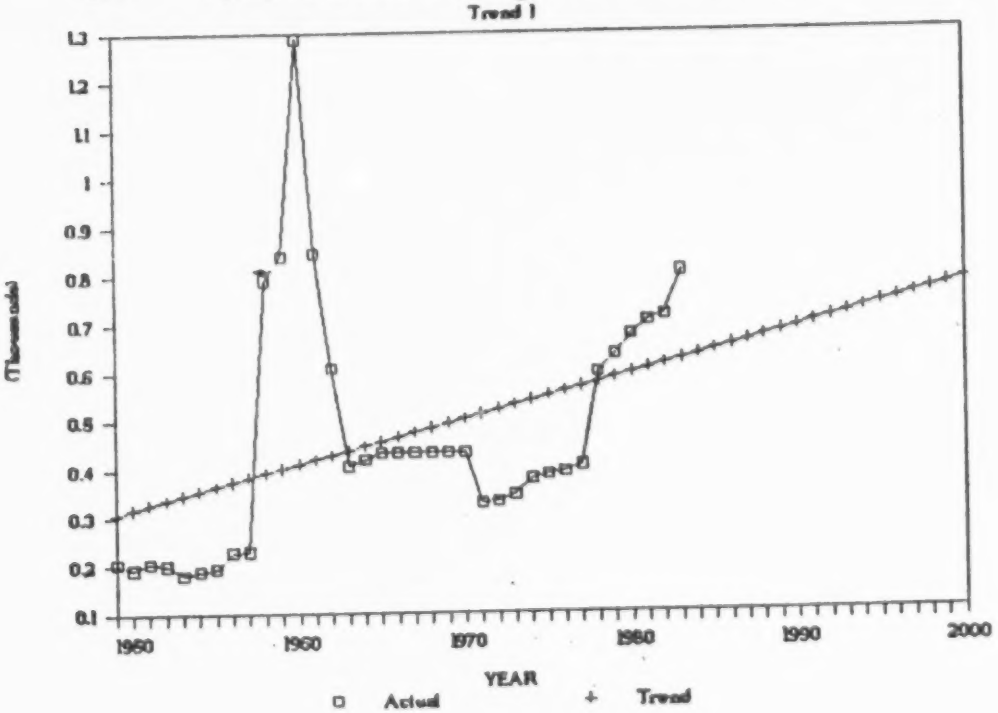
XVI New Admissions to Higher Education



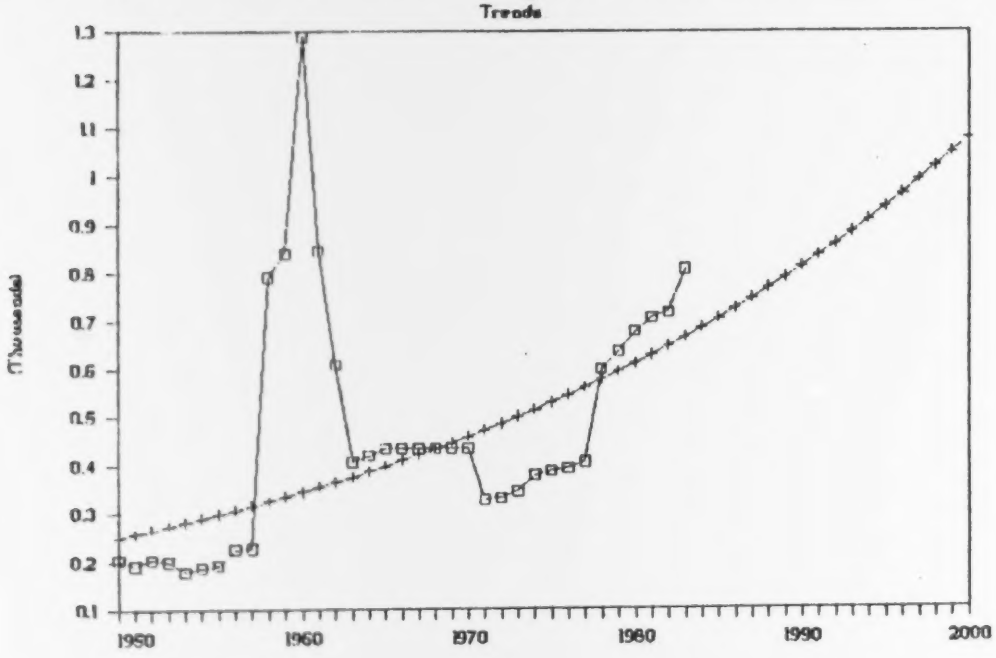
XVII New Admissions to Higher Education



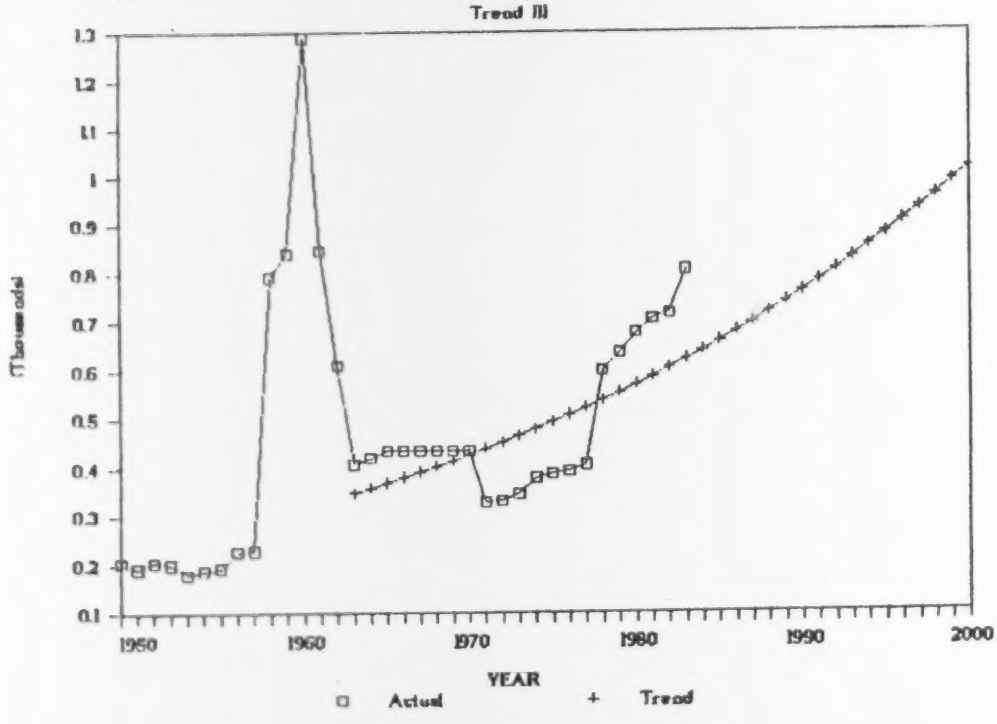
XVIII Institutions of Higher Education



XIX Institutions of Higher Education



XX Institutions of Higher Education



Lecture 13

Financing of education: an economic analysis and its application to China's higher education

by Cheng Kai Ming

Introduction

Educational planners in China are not necessarily economists, nor are they accountants. However, the principles of economic analysis infiltrate into almost all crucial aspects of educational planning. It is therefore necessary for an educational planner to realize at least in principle the basic issues in the economics of education.

Benefits of education

There were once debates in China over the issue: 'Is education a matter of productivity?' The debates, which occured in the late 1970s and early 1980s, went into philosophical definitions of education and production and seemed to have created more puzzles than people expected to solve. To educational planners, this issue is not so realistic as one of how education can contribute to the improvement of productivity. The basic assumption in educational planning is that education does improve productivity. This is viewed as one of the benefits of education.

In many cases, the benefits of education is tangible in monetary terms. In a market economy, where salaries are often regarded as reflections of abilities, the increase in earning is often regarded as a proxy of improvement in productivity. In rural economies, the growth in production, in real quantity, indicates the improvement in productivity. If these are correlated to the amount of education that people receive, we can talk about benefits of education.

In China, particularly in the industrial sector where salaries are not functions of productivity, the benefit of education is not always easily enumerable. However, there is a common belief in China that education produces skilled manpower, and skilled manpower improves productivity. Although such a statement deserves some closer examination,[49] it is to be congratulated that planners in China work in an environment where people still place high values on education.

Benefits of education are not always realized in a direct form. For example, when education produces more medical doctors, the benefit is not only reflected in the productivity of doctors (or in their income) but also in the improved health standard of the entire community. When education produces more transport engineers, there is not only the benefit because of the roads, bridges and railways they built, but also the economic benefits brought about by the improved transportation system. It may be argued that children of educated people tend to receive more education, such a benefit does not materi-

[49] A thorough-going analysis of the benefits of education in the context of China can be found in Li Yi-ning Economic of Education, Beijing University, 1982.

alize in the parents themselves. It may also be argued that when more people become educated, people will live in a better social environment and the benefit is enjoyed by the entire society. Such benefits are sometimes referred to as externalities or 'spill-over' benefits of education. Such benefits are easier mentioned than enumerated, but their existence should be born in mind when we plan education.

The usual problem, and it might be even so in China, is not with the benefits but with the costs of education.

Costs of education

Costs easily escape attention of the educational planners. In other countries, when planners are also accountable for the efficient use of resources, they tend to pay their attention to the financial side of the costs and neglect the economic side. The financial cost of education is the money that one has to spend for the development of education. The economic cost of education, on the other hand, is the benefit that would otherwise occur if education is not developed. The latter is also called the 'opportunity cost'.

For example, the financial cost of university study is the money spent to support the university students, including the recurrent costs for teaching and the capital costs for the construction and equipment of the buildings. The economic cost, however, includes as well the loss that incurs due to the students absence from work. For the student himself or herself, he or she has foregone his or her salary which he or she would otherwise be earning. For the society at large, there is a loss of production which would otherwise be obtainable from the student.

Such economic costs are easily neglected particularly when the economy is communal and the cost is not directly incurred by the spender, i.e. in cases when rices are distributed from the 'big cooker' (*daguofan*).

It may be interesting to examine how such costs incur in some of the practices in higher education reform.

Compensated-allocation (youchang fenpei)

In *compensated allocation*, the enterprise has to pay a fee when they are allocated graduate manpower from the universities. This fee is paid retrospectively to compensate for (or partially for) the expenditures of training that graduate. In this case, the entire cost to the enterprise is the fee paid. This normally covers the only part of the recurrent expenditures[50] The major part of the recurrent costs, the entire capital costs are borne by the society (government expenditure), but the production foregone is totally borne by the society.

On the one hand, one may argue that the enterprise is not paying the full cost for producing a university graduate. On the other hand, the enterprise may argue that they are already paying more than the other enterprises where manpower is allocated free.

Both arguments are sound. Conventionally, the costs of education in China are borne by the government. This is still the case. It is almost impossible for the enterprises to bear the full economic costs of higher education. From the stand point of the enterprise, the

[50] In Dalian, the fee is RMB2,000 while the recurrent expenditure for four years is RMB4,400-4,800.

fees paid in *compensated allocation* is in fact *not* to compensate cost of training (not even the financial cost), but to gain the privilege of getting manpower supply outside the normal allocation scheme. Such manpower would otherwise be unavailable. The enterprise is willing to pay this fee in the hope that this will be repaid by the future improvement of production because of the employment of the university graduates. The university, on the other hand, receives the fee as a way to cover the shortage of funds because supply from government sources is not adequate. Hence, if we examine carefully, *compensated allocation* is a mechanism to shift part of the training costs from public funding to enterprise funding. It is a way of taxation or levy. This is possible only because there is a desperate demand of manpower in the enterprises. After all, the major part of economic costs is till not borne by the enterprises.

Commissioned training (weituo daipei)

There are two different cases in the *commissioned training* schemes. In the first case, the trainees are freshly recruited students. They are not yet part of the enterprise's labour force. The enterprises pay for the recurrent cost or even some of the capital costs for the commissioned training. The economics is then similar to *compensated-allocation.* The enterprise do not bear any costs due to the production foregone during the training.

There are, however, two slight but significant differences between *compensated allocation* and *commissioned* training . Firstly, in the latter, the fees are paid during the training and the enterprise plan for this supply of manpower years ahead. In principle, it is therefore the enterprise which is looking for universities to fulfil its manpower plan. Once the training starts, both sides are committed to the plan. This is not the case in compensated allocation . There there is no commitment on the part of the enterprises before the students graduate and are allocated to the enterprises. This explains the second difference, that the fees paid in commissioned training is much higher than that in *compensated allocation.* In the latter case, no enterprise has any monopoly over any part of the graduates. In any case, the production foregone during training is still borne by the society and not by the enterprises.

In the second case of commissioned training, the students are originally employees of the enterprises. In this case, the workers leave their job to undergo training. The enterprise is then not only paying the fees, but it has to take into account also the loss of manpower during the period of study. The production foregone is borne this time by the enterprise. This happens in all sorts of off-job in-service training.

Cost-benefit analysis

It is immediately clear that if we take the economic costs of higher education into account, then we have to have a means to enumerate the benefits. A sensible decision can be made only if we can compare the costs with the benefits. If an enterprise is sending its employee to a university for a four year training, how does it know that the costs due to both the economic losses can be covered by the benefits acquired when the employee graduates from unversity?

In the Western society, higher education is a worthwhile activity for an individual if the additional income due to education in his/her lifetime is greater than the income foregone during the period of study.

In any society, higher education is a worthwhile investment if the benefits due to increased education is greater than the total cost due to (a) the supply of education and (b) the corresponding manpower foregone.

In China, *commissioned* training or *compensated allocation* is worth the while if, for the enterprise, the growth of productivity due to the increase of graduate manpower can cover the cost of paying the fees and the possible manpower foregone. Some enterprises appoint commissioned trainees by contract, to make sure that the trainee will at least work for a certain number of years. This is a sensible move based on the account of costs and benefits, that the benefits brought about by the trained employee in the contract years will cover the economic costs due to his training.

Along the same line of argument, in-service training or re-training is usually more economical. By in-service training we mean the case where the workers work full-time and undergo training after work. In this case, the production foregone is trivial.[51] This is quite different, economically, from the case when a worker is given a leave to study, be it a year, a month, or two hours in a day.

From the society's point of view, off-job training is always more expensive because of the production foregone. Adult part-time education is therefore usually preferred over institutional education.

There are two points that should be notices. Firstly, cost-benefit analysis on education alone is insufficient for a government to decide on its education policy. A real rational deliberation would require a comparison of cost-benefit analyses in different areas of social policies, and decide which area allows the most beneficial investment. Even in education *per se*, it requires a comparison of cost-benefit analyses to decide which sectors or which forms of education should be given better priorities. Unfortunately, very few country have ever done this. Secondly, recently there are calls in China that universities should become self-financing, or even incoming generating, the so called notion of universities as 'triple centres'.[52] Such calls can hardly secure support on economic grounds. Although we can safely assume that there are benefits derived from education, such benefits are harvested elsewhere but not within educational institutions. It is the society that is doing the investment, not the educational institutions. In *compensated-allocation*, for example, the fees are paid as a way of compensating for the expenditures. It is not a benefit for the university. It is actually a way of 'taxing' the enterprises. The same is with commissioned training . The fees are meant to support the operation of the universities. It is a way of mobilizing alternative sources of resources. Universities themselves are not able to generate profit just because of producing skilled manpower. The skilled manpower will become profit generating only when they become employed by some production enterprises.

The exceptions are the research institutes. Some of the research institutes are production-oriented and actually belongs to the production sector. They can generate profit by 'selling' their research products. This is also the case with the factories attached to and operated by the universities. They are just not different from the enterprises in the industrial sector and are no part of the education machinery.

[51] There are arguments that even if the worker works full time, the part-time study takes away his time for leisure and rest and lowers his productivity.

[52] The 'triple centre' notion says that universities, in addition to being a centre for teaching and centre for research, should also be a centre for income generation.

The issue of financing

One issue that follows immediately from cost-benefit analysis is the problem of financing: Who should bear the cost?

This attributes to two elements: the efficient utility of resources and the problem of equity.

One obvious argument is that since the benefits of education can only realized in the society, the society as a whole should bear the cost, hence the government should pay. The advantages of government financing is (a) there can be better co-ordination and hence higher efficiency in the utility of resources; (b) the universities can be relieved from financial burdens and concentrate on its own duties. There are, however, disadvantages of government financing. First, it denies the possibility of mobilizing other sources of finance; secondly, the enterprises may be less enthusiastic to render support to education and, accordingly and thirdly, the education institutions will be less sensitive to needs of the community. In sum, it denies the advantage of Chinese notion of 'supplier-consumer inter-action' (*gongxiao jianmian*). There is also the additional disadvantage that government financing usually means more administrative binding and less autonomy.

One alternative to government financing is enterprise-financing. *Commissioned* training and *compensated allocation* are just two particular cases of this financing mode. The argument is that since the enterprises are the consumers of the product of education, they should bear the costs. This gives the advantages of causing the enterprises and institutions to be sensitive to each other, lessens the financial burden for the government and causes less administrative inconvenience. The major disadvantage of enterprise-financing is that policies of higher education institutions will then be largely shaped by short term and parochial needs of the enterprises and achievement of long term goals will become difficult. It will also cause difficulties to the academic areas with less direct applications, either in basic disciplines such as pure science or philosophy, or in areas that are not useful in a pragmatic sense, such as art and music. Studies in such area are essential to the society but are not attractive to the enterprises. The other disadvantage is that the disparity of manpower distribution will be increased. Wealthier enterprises will have more resources to commission training and will become even better equipped in manpower. Less wealthy enterprises or those who are not meant to make great profits will be deprived of supply of manpower. In the Chinese context, such enlargement of disparity may even exist among provinces.

Student self-financing is another alternative. This is not likely to spread in China in the near future. The reasons are (a) the unit cost is too huge a sum when compared with normal salaries; (b) the additional income due to higher education does not constitute sufficient incentive for students to pay. For the time being, there could be three kinds of benefits for self-financing: (1) to 'buy' the right of selecting jobs; (2) to maintain urban residence and, in some cases (3) to buy the opportunity of doing higher education. Recently there is a news that in some places, students are made to compensate for their costs of higher education when they refused to be take up an allocated job. Economically, this may easily turn into a way of 'buying' a right to select jobs, if jobs in the free market are more favourable. In any case, the present salary differential between a secondary school graduate and a university graduate is still not significant enough to justify self-financing of higher education.

Self-financing will again create the problem of inequity. Higher education places will go to better-off families. One solution to this problem is to establish student loans, so that

students will not be deprived higher education merely because of family financial abilities. The problem with student loans in China is that students are not likely to be able to repay, given the low level in their future salaries. One way to go round this is make the employers pay. This is in fact already happening in *compensated allocation* and *commissioned training.*

Part II
Practical exercises

Practical Exercise No. 1

Analysis of the structure of the industrial sector

For the preparation of the practical exercises of this workshop a particular effort has been made for gathering data on education and employment in the province of Henan. It has not been possible however to collect the data about the value added (i.e. the contribution to total production) of the various sectors of activity. We cannot therefore analyze directly the structure of the industrial sector and its growth during the period 1980-1985. Data about qualified manpower are however available. We have, in fact, two sets of data. The first set of data relates only to the year 1984 and gives the distribution of qualified manpower according to the following sectors of activity:

- Agriculture
- Industry
- Energy and construction
- Transport and communication
- Trade, hotel and restaurantion
- Finance
- Administration
- Public service
- Education and health
- Research

The second set of data relates to the period 1980-1985 and gives the distribution of qualified manpower according to the following categories:

- Engineering
- Agriculture
- Research
- Medicine and sanitation
- Education
- Accounting
- Statistician
- Publication
- Interpretation
- Lawyer

- Art

These two sets are available under the form of a Lotus 1,2,3 worksheet which you can use for computation and analysis purposes.

Exercise on the first set of data

1. What are the sectors which employ the highest proportion of qualified manpower? What comments would you offer about the use of qualified manpower in the province of Henan? Is the situation similar in other provinces of China?

2. What are the enterprises and the services which are included in the sector Industry. If the sector Industry can be broken down into more homogeneous sub-sectors both from the point of view of technology used and that of the structure of qualified manpower, what type of breakdown would you suggest?

3. What are the other sectors which should also be broken down in order to improve the analysis about the use of qualified manpower?

Exercise on the second set of data

1. Compare the data of the first data set with the data of the same year (1984) in the second data set. What are the reasons which may explain the difference?

2. Is the classification used for the sector of Activity in the second set of data more suitable for the analysis of the distribution of qualified manpower? Give your reasons.

3. The second set of data gives details about the level of education of qualified manpower. We will use this detailed breakdown in another exercise. For the time being let us concentrate on figures about total qualified manpower. Using Lotus 1,2,3 compute the percentage of total qualified manpower employed in the various sectors. What are your comments about the distribution observed?

4. Compute with Lotus 1,2,3 the annual rate of growth of qualified manpower in the various sectors. What are your comments about the growth during the period 1980-1984?

Practical Exercise No. 2

Analysis of the structure of qualified manpower in the various sectors of activity

For this exercise we will use the two data sets about the distribution of qualified manpower to which you are already familiar. Here again you can use Lotus 1,2,3 for computation. The aim of the analysis is:

(a) To find the distribution of various categories of qualified manpower in the different sectors of activity.

(b) To compare and identify differences observed in the different sectors of activity.

(c) To determine the type of training received by the various categories of qualified manpower in the different sectors of activity.

(d) To extract relevant data for forecasting the future demand of qualified manpower and for projecting new admissions and enrolment of Higher Education Institutions.

The extent to which the analysis can be conducted depend upon the reliability and relevance of the information available.

Exercise on the first set of data

1. Distribution of specialized qualified manpower in the different sectors of activity.

(a) Compute for each category of specialized qualified manpower its percentage distribution among the various sectors of activity (percentage column-wise). What comment would you offer about the distribution of each category of specialized qualified manpower in the various sectors of activity?

(b) Is the breakdown of specialized qualified manpower into five categories (Researcher, Engineer, Agronomist, Doctor, Teacher) suitable for an analysis of the use of qualified manpower and for the forecast of the demand of qualified manpower? How can you improve the classification?

2. Distribution of specialized qualified manpower within each sector of activity.

Compute for each sector of activity the percentage distribution of specialized qualified manpower (row-wise percentage). What comment would you offer about the distribution observed?

(a) What is the proportion of Engineers in the various sectors of activity? What is the education and training received by these different categories of Engineers? How can the Engineers be regrouped in a sub-category which may be more homogeneous?

Exercise on the second set of data (1980-1985)

In this second set of data you can find the level of education of different types of occupation in various sectors of activity. For the analysis we will begin with the data of the year 1984.

1. For each sector of activity there are three categories of qualified manpower. In the engineering sector, for example, there are senior engineer, engineer and others. Who are the others? What is the proportion of the others? How would you sub-divide these "others" in sub-categories in order to improve the analysis?

2. Compute the percentage distribution of each category of qualified manpower by level of education (percentage row-wise) in 1984. What comment would you offer about the distribution observed for the various category of qualified manpower in the different sectors? What is in particular the distribution of "others" by level of education?

3. Compute the percentage distribution of each category of qualified manpower by level of education in 1980. What are the changes you can observe comparing the situation in 1980 and 1984?

4. Compute for 1980 and 1984 and for each level of education the percentage distribution of qualified manpower among the different sectors and occupations. What comments would you offer?

5. Compute the annual rate of growth between 1980 and 1984 of post-graduates, of graduates and of Diploma holders for the different sectors of activity and occupations. What are your comments about the relative growth observed in the different sectors?

Practical Exercise No. 3

Analysis of the diversity of higher education institutions and profile of graduates

For this exercise we shall use the data set about the enrolment in higher education institutions in the Henan province which is available under the form of a Lotus 1,2,3 worksheet. There are six tables giving enrolment statistics by institution for six years (1980-1985). The objective of the analysis is:

(a) To determine the respective roles of the state, provincial and regional governments in the development and operation of higher education in the province of Henan.

(b) To identify the degree of diversity of higher education in terms of (i) control, (ii) discipline and (iii) duration of studies, and analyze the evolution of the diversity.

(c) To compare the advantages and disadvantages of diversity in higher education.

(d) To determine whether the diversity has any relation with the profile of graduates, what has been its evolution and what are the likely consequences for the economic and social development of the province.

(e) To compare the diversity of higher education and the profile of graduates in Henan province with the participants' own provincial experience, with that of the whole country and with other countries.

Exercise on the diversity of higher education

1. Does the classification given in the tables shed light on the roles of state, provincial and regional government in higher education in Henan? If not, what further information do you think is required? (Note: Among the institutions listed under the provincial category in the tables, Yunan Agriculture School, Xinxiang, Zhumadian, Pingdingshan and Kaifeng teachers schools are controlled by regional (sub-provincial) government. All branch schools are under the control of the provincial Bureau of Education. All short cycle vocational schools are under regional/city government).

2. Role of different agencies in higher education in Henan: compute for each type of control (state, provincial and regional) of higher education institution, the percentage of enrolment for the year 1984. Explain the rationale of the different types of control. What other types of higher education are missing? List them. Compare the situation with that of your own province.

3. Analyze the phenomenon of diversification by characteristics such as: (i) control, (ii) discipline and (iii) duration of studies, for the years 1980 to 1985. (Hint: control as in 2. above. For disciplines, group all institutions of Ministeres as Engineering except the Management School for Aviation, Zhenzhan University, branch schools and non-resident universities as "multidisciplinary"; use your judgment to identify the disciplines of other institutions. For duration of studies, there may be 3 categories: postgraduate, undergraduate and three year courses).

Compute the percentage of enrolment for each sub-characteristic of the total and the average annual growth rate of enrolment for each of them. Interpret the results and derive implications for policy.

4. Is there any association between the controlling authority of an institution and the discipline(s) it offers? Explain.

5. (a) List the advantages of diversification in terms of control, disciplines and duration; (b) List the disadvantages of diversification. Compare the situation with that of your own province and the international examples given to you in the plenary.

Exercise on the profile of graduates

(Hint: Since data on graduates are not available to make estimates, use "proxy" measures. For example, the final year students of the undergraduate and three year courses will be used as "proxy" for the respective graduates. For postgraduates, the students will be "proxy" for graduates).

1. Compute the percentages of graduates as estimated above for:

(a) State institutions, provincial and regional institutions;

(b) Disciplines, namely, engineering, medicine, agriculture, management, teacher training and "multidisciplinary"; and

(c) Duration of studies, e.g. postgraduate, graduates and three year courses for the years 1980 through 1985 and interpret the results for policy decisions.

2. Compare the average annual growth rates for different types of graduates during the period 1980-1985 and derive implications for policy.

3. Comment on the relevance of the output of graduates with the socio- economic needs of Henan (consult the background information supplied).

4. How does the profile of graduates in Henan compare with that of the whole country and other countries of the world? (ref. plenary session).

5. How does the profile in Henan compare with that of your own province? Explain differences if any.

Practical Exercise No. 4

Analysis of past trends in the development of higher education in China

For this exercise you will use the data on new admissions on enrolment and on graduates by field of study during the period 1950-1982 which are available in a Lotus 1,2,3 work-sheet.

Analysis of the trends of total enrolment 1950-1982

Using Lotus 1,2,3 produce a graph showing the trends of total enrolment during the period 1950-1982. How would you subdivide that period into sub-periods?

Present your comments about the trend of higher education enrolment during each of these sub-periods.

Analysis of the trends and of the share of enrolment by field of study

Produce for each of the following specialities:

- Engineering
- Teacher training
- Agriculture
- Finance and Economics
- Political sciences and Law
- Medicine and Pharmacy

a graph on the trends of enrolment during the period 1950-1982 and a graph on the percentage share.

Interpret each of these graphs and give your detailed comments.

Practical Exercise No. 5

Introduction to the use of simulation models

The three following exercises (Nos. 6, 7 and 8) relate to:

- qualified manpower projection;
- higher education enrolment projection;
- teaching staff, non-teaching staff and recurrent expenditures projections.

To do these exercises, you will use the three simulation models which have been developed on Lotus 1,2,3. The choice of this spreadsheet package is made both because it is very user friendly and because it is extensively used. It should however be borne in mind that other spreadsheet packages could be used as well.

The aim of this series of exercises is to familiarize yourselves with projection techniques and with the use of microcomputer and worksheet programmes to simulate different set of decisions and analyze their long term effects.

You will note that the cells containing data about the present situation of the People's Republic of China or data about other countries for comparison purposes as well as the cells expressing relationships between the different variables of the model are protected. You cannot therefore change them. What you can change is only the policy variable or the targets to be achieved in year 2000, which is the horizon year for the three projections.

The manpower projection model

It is very similar to the Mediterranean Regional Project model.[1] Its aim is to project the demand of graduates of tertiary level according to different sets of assumptions about:

(a) the growth rate of the Gross Domestic Product per capita and the growth rate of population;

(b) the projected share of the contribution to GDP of the main economic sector of activity;

(c) the projected employment distribution by economic sector of activity;

(d) the projected occupational structure by economic sector of activity;

(e) the projected educational attainment of workers in each occupational group.

These sets of assumptions should be determined by planners and policy makers, on the basis of macro and micro studies on economic growth and on manpower utilization. Some comparative statistics on selected Asian countries are, however, shown in the model, serving as a very rough guidelines to user in choosing the appropriate values for the parameters. The drawback of the international comparison approach have been well documented and therefore will not be repeated here.[2]

[1] H. Parmes, Forecasting educational needs for economic and social development, OECD, Paris, 1984.

In order to keep the worksheet within a manageable size and complexity, the inter-relationship between some parameters have not been catered for in the model. In other words, they are considered as independent variables. For instance, the sectoral distribution of production (value added) is related to GDP growth rate; the level of population growth rate would naturally affect the mix of final demand for goods and services and hence the sectoral distribution of industrial output and employment; the change in educational attainment of the work force may lead to change in work arrangement and hence the occupational structure, which in turn is correlated to the productivity of the industry concerned. In fact, some of these inter-relationships are not even taken into account in many manpower forecasting exercises conducted in many countries.[3] The users should not therefore be deceived by the simplicity of the model.

The statistical information required for constructing the model can broadly speaking be classified into three groups.

Macro economic statistics on GDP

The two main sets of GDP data concern the distribution of production (value added) and the distribution of employment by economic sector of activity. From these two sets of data it is possible to derive the value added per employment unit (or average productivity) by economic sector of activity.

The GDP data are usually collated by the national authorities mainly for purpose of economic analyses.

Statistics on the matrix occupation/education by sector of economic activity

These statistics are usually extracted from population census, general purpose household survey or manpower surveys specially conducted for selected occupational or industry groups.

Educational statistics on graduates from Higher Educational institutions

The statistics on China used in the model are taken from the 1982 population census data and other published sources.[4] Statistics for other countries shown in the model are based on the statistical yearbook published by the respective countries.[5] The base year for the manpower forecast is 1982 and target year is 2000.

The worksheet comprises four parts as follows:

- Part 1: Structure of Production, Employment and Productivity by Economic sectors; Assumptions for GDP and Population Growth rates up to the year 2000;

[2] R.V. Youdi and K. Hinchliffe (Ed), Forecasting skilled manpower needs: The experience of eleven countries, Unesco/IIEP, Paris, 1985.

[3] See for example R.V. Youdi and K. Hinchliffe (Ed), op. cit., Unesco/IIEP, Paris, 1985.

[4] Achievement of Education in China: Statistics 1949-1983, Peoples' Education Press, Beijing, 1985; World Bank, *China: Long term issues and options*, 1986; World Bank, *World Development Report*, 1984.

[5] Japan Statistical Yearbook; Statistical Yearbook of Indonesia; Korea Statistical Yearbook; Singapore Census of Population 1980.

- Part 2: Structure of Occupation by Economic sector;

- Part 3: Distribution of manpower by educational attainment;

- Part 4: Estimating the required number of Higher Education graduates during the period 1983-2000.

The following paragraphs give a brief description of the four parts of the model. Details about the formulae used in the model would not be given here, as users can always refer to the worksheet.

Part 1. Growth of GDP and of the net output per worker by economic sector

This part of the model presents an analysis of the distribution of value added and of employment by economic sector and permits users to assign targets for selected macro-economic parameters. The organization of Part 1 in the worksheet is as follows:

Table 1 gives the distribution of value added and employment by Economic sector in China in 1982.

Table 1

Value added and employment by economic sector (China, 1982)

	Value added		Employment		Net output per worker
	Yuan (million)	%	('000)	%	Yuan
Agriculture and fishery	156 600	36.1	314 870	69.6	497
Mining & quarrying	35 310	8.1	7 810	1.7	4 521
Manufacturing	132 560	30.6	56 160	12.4	2 360
Electricity, water and gas	10 630	2.5	1 100	0.2	9 664
Construction and public works	18 200	4.2	10 810	2.4	1 684
Transport, storage and communication	15 400	3.6	8 600	1.9	1 791
Commerce	28 300	6.5	14 570	3.2	1 942
Services	36 530	8.4	38 250	8.5	955
Total	433 530	100.0	452 170	100.0	23 414

Table 2 allows user to assign values to the following parameters:

(a) Annual growth rate of GDP per capita between 1982 and 2000;

(b) Annual growth rate of population;

(c) Percentage of Population in the labour force in 2000;

(d) Distribution of value added and of employment by economic sector in year 2000.

It may be noted that (a) and (ab) combined will determine the target GDP and (d) affects the value added per employment unit (or average productivity) in the target year.

Table 3 provides comparative statistics for Japan for the years 1970 and 1980 to give users a broad indication of the magnitude of changes over time in the labour productivity in different economic sectors.

Users are suggested to vary the growth rates for GDP per capita and population and see how they affect the overall GDP (in Table 2). They should also vary the distribution of value added and of employment and see how they affect the growth rate of the net output per worker (or average productivity). They can countercheck their assumptions as regards the value of these four parameters by comparing the resulting growth rate of average productivity by sector with the corresponding observed growth rate in Japan during the period 1970-1980 to avoid unrealistic assumptions.

Part 2. Change in the occupation structure.

This part of the model shows the occupation structure by economic sector in China in 1982. Users of the model will have to assign value to the target occupation structure for the year 2000. For the intermediate years the occupation structure will be interpolated by the model. Since the concern of the model is with the projection of qualified manpower coming from higher education, only three main occupational groups are considered: professional and technical workers, administrative and managerial workers and the very broad group of other workers. To guide the user in setting the occupation structure for the years 2000, comparative statistics for Indonesia, Singapore and Japan have been provided.

The organization of Part 2 in the worksheet is as follows:

Table 4 gives for reference purposes the occupation matrix by economic sector of China in 1982.

Table 5 permits users to assign the target occupation structure for the different economic sectors in the year 2000.

Table 6 gives the resulting employment in the three main occupation group.

The computation is done automatically on the basis of the value given by the users in Table 5 and the total employment by economic sector in Table 2 of Part 1 of the model. The overall occupation structure for all economic sectors are also computed by Table 6. Data about the occupation structure of Japan for 1970, 1975, 1980 and 1984 are given in the same table for easy comparison.

The stability and predictability of the occupation structure is an essential feature in a manpower forecasting model but is also its main theoretical weakness. While the debate will not be repeated here, the users may take advantage of the computational power of the model to test how variations in the occupation structure would affect the demand for qualified manpower. This kind of sensitivity test may give users an idea about the so called "confidence intervals" of their forecasts.

Table 2

Basic data and assumptions for year 2000 (Assumptions are underlined)

	1982	Assumed rate of growth	2000
GDP/capita (Yuan)	723	5.0	1 740
Population (million)	1 008	1.0	1 206
GDP (million Yuan)	729 120	6.0	2 098 897

	Assumed % of population in labour force	Labour force in year 2000
Labour force (thousands)	52.8	636 253

	Value added in 2000		Projected employment in 2000	
Sector	Assumed %	Yuan (million)	Assumed % dist.	(000)
Agriculture and fishery	23.3	489 043	52.3	332 697
Mining & quarrying	7.6	159 516	1.5	9 289
Manufacturing	27.7	581 394	14.9	94 993
Electricity, water and gas	4.3	90 253	0.2	1 527
Construction and public works	4.4	92 351	3.6	22 714
Transport, storage and communication	4.6	96 549	2.9	18 515
Commerce	10.1	211 989	10.0	63 625
Services	18.0	377 801	14.6	92 893
Total	100.0	2 098 897	100.0	636 253

Note: The figures underlines are assumptions to be introduced by the student. The other figures are computer by programme.

Table 3

Percentage growth of net output per worker by economic sector -Japan 1970-1980

	1970			1980	1970-80		
	Value added	Employment ('00	Net output per worker (Yen)	Value added (Million Yen	Employment ('00	Net output per worker (Yen)	% growth of net output per worker
Agriculture	7,188	8,860	811	7,368	5,770	1,277	4.6
Mining & qua	820	200	4,100	1,049	110	9,536	8.8
Manufacturin	35,142	13,770	2,552	69,462	13,670	5,081	7.1
Electricity,	2,360			3,659			
Construction	10,957	3,940	2,781	15,259	5,480	2,784	0.0
Transport, s	7,381	3,530	2,759	11,946	3,810	4,096	4.0
Commerce	29,551	11,440	2,583	55,485	14,390	3,856	4.1
Services	24,445	9,120	2,680	24,569	12,000	2,047	-2.7
TOTAL	117,844	50,860	18,267	188,797	55,230	29,678	4.6

Part 3. Projection of the educational attainment of the main occupation groups

The organization of this part of the model is as follows:

Table 7 gives the Educational attainment of workers in the three main occupation groups in China in 1982.

Table 8 permits user to assign the target proportion of qualified manpower with higher education among the professional and technical, administrative and managerial and other workers for the year 2000.

For convenient comparison, data about educational attainment of workers in Singapore and in the Republic of Korea are also given by the worksheet.

Part 4. Estimating the number of graduates required between 1982 and 2000

This part of the model as shown in Table 9 below is fairly straight forward. It computes on the basis of the total qualified manpower required every year by the economy, the number of Higher Education graduates taking into account the additional number of workers, the replacement of those who retire and the proportion of graduates who do not, for various reasons, participate in the labour force.

Table 4

Sectoral-occupational matrix

	Professional /technical	Admin. & managerial	Clerical workers	Sales workers	Service workers	Agricultural workers	Production workers	Others	TOTAL
Agriculture	279	44	26	20	68	37,402	594	2	38,435
%	0.7	0.1	0.1	0.1	0.2	97.3	1.5	0.0	100.0
Mining & qua	75	36	30	9	68	42	638	2	900
%	8.3	4.0	3.3	1.0	7.6	4.7	70.9	0.2	100.0
Manufacturin	389	228	128	130	338	31	4,907	24	6,175
%	6.3	3.7	2.1	2.1	5.5	0.5	79.5	0.4	100.0
Electricity,	15	9	7	2	11	2	103	1	150
%	10.0	6.0	4.7	1.3	7.3	1.3	68.7	0.7	100.0
Construction	75	30	24	7	40	7	907	4	1,094
%	6.9	2.7	2.2	0.6	3.7	0.6	82.9	0.4	100.0
Transport, s	62	36	74	7	81	21	619	2	902
%	6.9	4.0	8.2	0.8	9.0	2.3	68.6	0.2	100.0
Commerce	205	117	72	734	226	10	274	3	1,641
%	12.5	7.1	4.4	44.7	13.8	0.6	16.7	0.2	100.0
Services	1,546	310	316	29	317	36	281	10	2,845
%	54.3	10.9	11.1	1.0	11.1	1.3	9.9	0.4	100.0
TOTAL	2,698	838	702	989	1,196	37,658	8,712	50	52,842
	5.1	1.6	1.3	1.9	2.3	71.3	16.5	0.1	100.0

Table 5

China: target occupational distribution by sector for year 2000

	Professional technical	Admin. & managerial	Other workers
Agriculture and fishery	1.5	0.6	97.9
Mining & quarrying	8.0	5.0	87.0
Manufacturing	9.0	6.0	85.0
Electricity, water and gas	9.0	5.0	85.0
Construction and public works	9.0	5.0	86.0
Transport, storage and communication	9.0	6.0	85.0
Commerce	12.0	7.0	81.0
Services	36.0	15.0	49.0

Higher education enrolment projection model

For the projection of Higher Education enrolment, we will use the well known flow rates model. The manpower projection model and the enrolment projection model are, in our case, independent models. The aim of the simulation therefore is to see how enrolment should grow in the future so that the number of graduates matches the required number of graduates which have been arrived at in the qualified manpower projection model.

In order to keep the worksheet within manageable size, we have simplified the very complex structure of Higher Education with its multiple categories of institutions. In the model only three types of programmes are considered. Their duration is respectively 3, 4 and 5 years.

The model is organized in the following way:

Table 10: Assumption about the graduation rate of Secondary Academic and Technical Education

The first step in the projection is estimating the trends about the number of graduates of Secondary Academic and Technical Education. The parameter used is the graduation rate i.e. the proportion of 18 years old population who are graduates from secondary education. The user have to set in Table 10 the value for the two graduation rates of secondary education for the horizon year.

Table 6

China: projection for year 2000

		Professional /technical	Admin. & managerial	Other workers
Agriculture and fostery		4 990 448	1 996 179	325 709 881
Mining & quarrying		743 143	464 464	8 081 681
Manufacturing		8 549 327	5 699 551	80 743 642
Electricity, water and gas		137 431	91 620	1 297 955
Construction and public works		2 044 280	1 135 711	19 534 299
Transport, storage and communication		1 666 346	1 110 897	15 737 709
Commerce		7 635 032	4 453 769	51 536 464
Services		33 441 439	13 933 933	45 517 514
Total	59 207 444	28 886 125	548 159 076	636 252 645
	9.3%	4.5%	86.2%	100.0%
Japan 1970	295	134	4 665	5 094
	5.8%	2.6%	91.6%	100.0%
Japan 1975	364	206	4 653	5 223
	7.0%	3.9%	89.1%	100.0%
Japan 1980	438	220	4 878	5 536
	7.9%	4.0%	88.1%	100.0%
Japan 1984	528	213	5 025	5 766
	9.2%	3.7%	87.1%	100.0%

Table 11: Assumption about the transition rate and the distribution of admission between the three types of programmes

The second step is fixing the transition from secondary to higher i.e. the proportion of secondary education graduates who can gain access to higher education.

Table 7

Educational attainment of workers

	Educational attainment				
	University	Senior Sec.	Junior Sec.	Primary	No school
Prof/tech.	347 080	1 173 161	858 683	255 739	9 601
Percentage	13.1	44.4	32.5	9.7	0.4
Adm./manager	51 386	176 180	347 329	217 886	15 684
Percentage	6.4	21.8	43.0	27.0	1.9
Workers	55 120	4 139 394	12 346 254	17 437 383	14 706 893
Percentage	0.1	8.5	25.4	35.8	30.2

Table 8

Distribution of manpower by educational attainment

	Target proportion of qualified manpower with higher education in the year 2000
Professional/technical	11 841 489
Percentage	20
Administrator/manager	4 332 919
Percentage	15
Workers	2 740 795
Percentage	0.5

As we have indicated before, only three types of programmes are considered by the model. After fixing the transition rate it is necessary to fix the distribution of new admission between the three categories of programmes to allow the projection of new admission in the three programmes.

Table 12: Projection of enrolment

For enrolment projections three flow rates models corresponding to the three types of programmes are needed. They all project total enrolment and enrolment by grade on the basis of new admissions previously projected and the flow rates of the system (promotion, repetition and drop-out rates). Table 12 about the programme of 3 year duration is given as an illustration.

Table 13 recapitulates the number of graduates of the three types of programmes and allows to compare the number of graduates from higher education and the qualified manpower required.

Table 9

Estimated number of university graduates required 1983-2000

	Number required to meet shortfall	Number required to replace retired/died workers	Number of new graduates to be employed	Number of university graduates required	Total number of graduates employed
1983	183 299	136 076	319 375	335 344	4 719 159
1984	255 717	141 575	397 292	417 157	4 974 877
1985	328 135	149 246	477 382	501 251	5 303 012
1986	400 553	159 090	559 644	587 626	5 703 566
1987	472 971	171 107	644 078	676 282	6 176 537
1988	545 389	185 296	730 686	767 220	6 721 927
1989	617 807	201 658	819 465	860 438	7 339 734
1990	690 225	220 192	910 417	955 938	8 029 959
1991	762 643	240 899	1 003 542	1 053 719	8 792 603
1992	835 061	263 778	1 098 839	1 153 781	9 627 664
1993	907 479	288 830	1 196 309	1 256 125	10 535 143
1994	979 897	316 054	1 295 952	1 360 749	11 515 041
1995	1 052 315	345 451	1 397 767	1 467 655	12 567 356
1996	1 124 733	377 021	1 501 754	1 576 842	13 692 090
1997	1 197 151	410 763	1 607 914	1 688 310	14 889 241
1998	1 269 569	446 677	1 716 247	1 802 059	16 158 810
1999	1 341 987	484 764	1 826 752	1 918 089	17 500 798
2000	1 414 405	525 024	1 939 429	2 036 401	18 915 203

Recurrent expenditures projection model

While the manpower projection model and the enrolment projection model are two separate and independent models, the recurrent expenditures projection model is closely linked to the enrolment projection model. It gives for each enrolment projection the corresponding level of recurrent expenditure. There are, however, various parameters which the user can change and see the effect on total recurrent expenditures (within each enrolment projection).

The model is organized in the following way:

Table 14: Projection of the number of teachers required

The parameter used in this Table is the student teacher ratio. At present this ratio is rather low 3.9. The user should assign value to this ratio for the three types of programmes (3, 4 and 5 years duration) for the horizon year. Of course, recurrent expenditures depend upon this parameter linked to the use of teacher since Teacher Salary constitutes a sizable part of total recurrent expenditures.

Table 15: Assumptions about the policy variables to be used for the recurrent expenditures projection

There are three sets of parameters which may affect the level of total recurrent expenditures:

The distribution of teachers by category.

At present there are five categories of teachers: Professors, Associate professors, Assistants, Lecturers and Instructors. Assistants, Lecturers and Instructors constitute the very large majority of the teaching force. For the horizon year, users may assign different values for this distribution;

The level of different unit expenditures.

Three unit expenditures can be distinguished: Direct Instruction Unit Expenditures, Administration Unit Expenditures and Student Welfare Unit Expenditures. Here also the users have to assign value to these unit expenditures for the horizon years;

The level of teacher salary.

As indicated above there are five categories of teachers. Taking into account the average salary of each category of teachers in 1982, the user should assign value to the average salaries in the horizon year. To guide the user in fixing the level of salary the GDP per capita in 1982 and the GDP in the horizon year are shown by the model.

Using the policy variables given by the user, the model computes the total recurrent expenditures of higher education both in absolute terms and as a percentage of GDP. The user can therefore compare the share of GDP devoted to higher education in 1982 to that of the horizon year and test the financial feasibility of his projection.

Table 16: Projection of the number of teachers by category

This Table is an intermediate table designed for computation purposes. The number of teachers per category is of course computed on the basis of the parameters given by the user. Similar Tables exist also for Total Salary Expenditures, Total Instructional Expenditures, Total Administrative Expenditures and Total Student Welfare expenditures.

Table 10

Computation about graduate rate

Year	Population aged 18 years	Assumed Graduation rate		Secondary graduates		
		Senior Secondary	Tech/ Vocat.	Total	Senior Secondary	Tech/ Vocat.
1981	27,377,430	17.8	2.2	5,465,920	4,861,000	604,920
1982	25,107,210	12.4	1.8	3,551,663	3,106,000	445,663
1983	24,431,440	9.6	1.5	2,726,353	2,351,000	375,353
TARGET for year 2000		20.0	10.0			
1984	25,659,430	10.2	2.0	3,147,766	2,625,798	521,968
1985	22,736,970	10.8	2.5	3,041,243	2,465,526	575,717
1986	24,522,950	11.5	3.0	3,551,915	2,808,885	743,030
1987	28,239,150	12.1	3.5	4,403,141	3,406,921	996,220
1988	26,495,510	12.7	4.0	4,424,912	3,358,293	1,066,619
1989	27,327,720	13.3	4.5	4,866,765	3,630,589	1,236,175
1990	25,216,880	13.9	5.0	4,770,322	3,504,085	1,266,236
1991	25,088,300	14.5	5.5	5,024,047	3,639,362	1,384,685
1992	24,030,680	15.1	6.0	5,078,582	3,632,630	1,445,952
1993	21,775,320	15.7	6.5	4,843,272	3,424,616	1,418,655

Table 11

Assumption about the transition rate and the distribution of admission between the three types of programmes (partial table)

	Secondary graduates			Transition rate	Admission rate	Number admitted			
	Total	Senior Secondary	Tech/ Vocat.			Total	3 years	4 years	5 years
1981	5,465,920	4,861,000	604,920	5.1	1.02	278,777	76,300	179,231	23,246
						100.0	27.4	64.3	8.3
1982	3,551,663	3,106,000	445,663	8.9	1.26	315,135	84,405	207,233	23,497
						100.0	26.8	65.8	7.5
1983	2,726,353	2,351,000	375,353	14.3	1.60	390,800	134,581	230,004	26,215
						100.0	34.4	58.9	6.7
	Target for year 2000			25.00			33.5	60.0	6.5
1984	3,147,766	2,625,798	521,968	15.0	1.84	470,955	161,925	277,496	31,534
							34.4	58.9	6.7
1985	3,041,243	2,465,526	575,717	15.6	2.09	474,099	162,744	279,668	31,687
							34.3	59.0	6.7
1986	3,551,915	2,808,885	743,030	16.2	2.35	575,992	197,403	340,162	38,426
							34.3	59.1	6.7
1987	4,403,141	3,406,921	996,220	16.8	2.63	741,655	253,770	438,497	49,387
							34.2	59.1	6.7
1988	4,424,912	3,358,293	1,066,619	17.5	2.92	773,084	264,098	457,600	51,386
							34.2	59.2	6.6
1989	4,866,765	3,630,589	1,236,175	18.1	3.22	880,815	300,415	521,961	58,439
							34.1	59.3	6.6
1990	4,770,322	3,504,085	1,266,236	18.7	3.54	893,289	304,177	529,955	59,157

Table 12

Projection of enrolment using the flow rate model (partial table)

	New entrants	Enrolment projection									
		I			II			III		Output	Total
1981	76,300	78244	1956		76288	1526		69389	694	68,140	223,921
		1174		763			555				
1982	84,405	85579	2054	75114	75877	1518	73999	74554	746	73,212	236,010
		1198		759			596				
1983	134,581	135779	3116	82327	83086	1584	73600	74196	714	72,918	293,061
		1840		794			564				
1984	161,925	163765	3585	130823	131617	2384	80708	81272	750	79,936	376,655
		2147		1200			587				
1985	162,744	164891	3435	158033	159233	2734	128033	128620	1137	126,605	452,744
		2088		1380			878				
1986	197,403	199492	3946	159367	160748	2608	155118	155996	1318	153,674	516,236
		2438		1322			1005				
1987	253,770	256208	4797	193108	194430	2971	156817	157822	1272	155,595	608,460
		3017		1513			955				
1988	264,098	267116	4719	248394	249907	3583	189946	190901	1464	188,356	707,923
		3027		1833			1081				
1989	300,415	303442	5041	259369	261202	3498	244491	245572	1788	242,488	810,216
		3304		1800			1295				
			4703	295098		3696	255904		1773		

Table 13

Projection of the number of graduates in the three types of programmes

Year	Graduates produced			
	Total	3 years	4 years	5 years
1981	326,573	68,140	226,264	32,169
1982	281,435	73,212	173,655	34,568
1983	270,214	72,918	172,414	24,883
1984	275,023	79,936	171,447	23,640
1985	347,279	126,605	198,367	22,307
1986	396,778	153,674	220,571	22,533
1987	446,928	155,595	266,236	25,097
1988	488,158	188,356	269,614	30,189
1989	600,556	242,488	327,535	30,533

Table 14

Projection of the number of teachers required in the three types of programmes

Year	Student-teacher ratio			Number of teachers required			
	3 years	4 years	5 years	Total	3 years	4 years	5 years
Target	10.0	12.0	12.0				
1981	3.9	3.9	3.9	289 811	57 416	196 135	36 260
1982	3.9	3.9	3.9	283 408	60 515	189 204	33 688
1983	3.9	3.9	3.9	307 938	75 144	201 544	31 250
1984	4.3	4.4	4.4	319 238	88 441	201 675	29 122
1985	4.6	4.9	4.9	327 996	98 046	202 257	27 692
1986	5.0	5.3	5.3	340 706	103 735	208 942	28 028
1987	5.3	5.8	5.8	371 670	114 044	227 482	30 143
1988	5.7	6.3	6.3	394 904	124 325	238 756	31 822
1989	6.1	6.8	6.8	424 703	133 855	257 311	33 536
1990	6.4	7.2	7.2	435 776	134 375	266 342	35 059
1991	6.8	7.7	7.7	441 281	137 020	268 040	36 220
1992	7.1	8.2	8.2	442 853	136 419	270 157	36 276
1993	7.5	8.7	8.7	434 093	134 405	263 761	35 927
1994	7.8	9.1	9.1	422 903	129 894	258 047	34 962
1995	8.2	9.6	9.6	409 085	125 106	249 811	34 168
1996	8.6	10.1	10.1	397 553	122 589	241 803	33 161
1997	8.9	10.6	10.6	401 052	124 986	243 229	32 838
1998	9.3	11.0	11.0	402 147	126 043	243 507	32 597
1999	9.6	11.5	11.5	402 273	126 508	243 369	32 397
2000	10.0	12.0	12.0	426 020	133 645	258 482	33 893

Table 15

Policy variables for the projection of recurrent expenditures

COST MODEL

Policy variables	1982			2000		
	5 year	4 year	3 year	5 year	4 year	3 year
Students/teacher	3.9	3.9	3.9	10.0	12.0	12.0
% of professors	6.5	1.8	0.0	10.0	5.0	0.0
% of ass. prof.	23.4	13.2	1.0	30.0	20.0	5.0
% of lecturers	40.6	53.2	40.4	25.0	40.0	60.0
% of assistants	15.6	14.4	42.6	30.0	25.0	25.0
% of instructors	14.0	17.4	16.0	5.0	10.0	10.0
Inst. unit costs	490	392	280	735	588	420
Adm. unit costs	686	630	560	1029	945	840
St. welfare unit costs	420	363	280	630	545	420
An.sal. prof.	!	3948			6500	
An. sal. ass.prof.	!	2856			4500	
An. sal. lecturer	!	2100			3200	
An. sal. assistant	!	1470			2300	
An. sal. instructor	!	2100			3200	
GDP per capita	!	868			2089	
Total Expenditures (million yuans)		2,076			10,576	
Maximum Expenditure					10,433	
% GDP on higher education		0.48			1.00	
GDP (million yuans)		433,530			1,043,342	

Table 16

Number of teachers by category

Year	Number of teachers by category				
	Professors	Ass. Prof.	Lecturers	Assistants	Instructors
1982	5 650	33 487	138 724	58 225	40 817
1983	6 132	35 734	149 283	66 552	43 693
1984	6 404	36 472	153 261	72 312	44 625
1985	6 728	37 429	156 446	76 515	45 082
1986	7 332	39 687	161 824	80 355	45 921
1987	8 415	44 358	175 855	88 312	49 081
1988	9 329	47 994	186 091	94 919	51 099
1989	10 514	52 918	199 505	102 572	53 787
1990	11 448	56 189	203 829	105 293	53 929
1991	12 139	58 292	205 539	107 326	53 376
1992	12 763	60 096	205 435	108 106	52 325
1993	13 038	60 275	200 579	106 597	50 077
1994	13 262	60 253	194 561	104 267	47 602
1995	13 374	59 741	187 342	101 349	44 893
1996	13 444	59 215	181 455	99 065	42 527
1997	13 968	60 800	182 605	100 471	41 815
1998	14 450	62 147	182 563	101 232	40 825
1999	14 916	63 400	182 036	101 728	39 728
2000	16 313	68 547	192 053	108 200	40 907

Practical Exercise No. 6

Manpower projection

We have introduced the data on China related to the situation in respect of GDP, GDP per capita, labour force by sector (industry), by industry and occupation, and by education and occupation, for 1982 into the computers that you are going to use. We have also projected, following the steps given in the presentation, the manpower requirements by different levels and types of education for the year 2000 based on certain hypothetical assumptions. These projections are only for the demonstration of the exercise and have nothing to do with the actual situation prevailing in China, nor the real forecasts the country is undertaking. This exercise is primarily meant for you to know what are the consequences of alternative policies and assumptions made today for the system of education tomorrow.

You will note that the parameters for projection are indicated by the bright figures on the screen. Using Lotus 1,2,3 you are to carry out the following tasks:

1. In the model for the manpower projection, the GDP per capita has been assumed to increase by 5 per cent per year on average. Analyse the changes in the net output per worker for each sector for GDP per capita growth rate of (i) 4 per cent, (ii) 6 per cent, and (iii) 7 per cent. Comment on the differences.

2. Would there be any changes in the manpower requirements by level and type of higher education if population in China would grow at an annual rate of 1.5 per cent instead of 1 per cent assumed in the model? If so, point out the changes and comment.

3. If the share of manufacturing in GDP for the year 2000 be required to change to 35 per cent and the employment in this sector to 20 per cent, what will be the implications for high-level manpower requirements?

4. Calculate the changes in the requirements of higher education graduates for the following changes in the occupation/industry matrix:

(a) proportion of professionals in year 2000 for manufacturing and services will be 25 per cent and 20 per cent respectively, or 30 per cent and 25 per cent respectively;

(b) proportion of administrators in the year 2000 for manufacturing and services will be 3 per cent and 20 per cent respectively, or 7 per cent and 25 per cent respectively.

5. If the proportion of professionals with university degree has to increase to 25 per cent by the year 2000, how many additional graduates would you need? Or, if you found that increase of professionals does not facilitate production of goods and services and you would like to reduce their proportion to 15 per cent in the year 2000, what will be the implications on the number of graduates?

6. To which of the following factors is the demand for high-level manpower more sensitive?

(a) proportion of professionals in the manufacturing sector;

(b) proportion of university graduates among professionals.

What kind of warnings do such results provide in the method of manpower forecast?

Practical Exercise No. 7

Higher education enrolment projection

To do this exercise you will use the simulation model which has been developed with Lotus 1,2,3. The aim of the exercise is to examine how higher education enrolment should grow in the future so that the number of graduates from the various higher education institutions matches the required number of graduates specified by the qualified manpower projection you have done previously.

For your projection you will need two kind of assumptions:

1) Assumption about the number of graduates from secondary education (Academic and Technical). The parameter used in the model is the graduation rate i.e. the proportion of 18 years old population who are graduates from secondary education. In 1983 the graduation rate of Academic Secondary education and of Technical Secondary education is respectively 9.6% and 1.5%. You have to assign a value for these two rates for the year 2000 which is the horizon year of the projection. The model interpolates the value of this parameter for the intermediate years.

2) Assumptions about the transition rate from secondary education to higher education. Two parameters should be taken into account. The first one is the transition ratio itself i.e. the proportion of graduates from Academic and Technical Education who are admitted to Higher Education. The second one is the distribution of new admission among the three types of programmes (3 years, 4 years and 5 years). Here also you have to assign value to these parameters for the year 2000.

You will have to make several simulations changing each time the value of the above indicated parameters. For each simulation you will check whether the number of graduates correspond to the number required by your qualified manpower projection.

At what rate should enrolment grow in the future in order to match the need for qualified manpower?

Please comment on the problems which higher education may have to face in order to ensure that steady growth.

Practical Exercise No. 8

Projection of recurrent expenditures of higher education

Projection of recurrent expenditures of higher education is closely linked to enrolment projection. The expenditure projection model uses as imput the number of students and their distribution among the three types of programmes (3 year, 4 year and 5 year programmes) you have arrived at in your previous projection.

The first assumption you will have to make for the projection of expenditures is the student/teacher ratio. At the present time it is rather low (3.9). To what extent may it be increased? You can check how total recurrent expenditures is sensitive to this parameter related to the efficient use of teachers.

You then have to make assumptions about a series of parameters which also affect total recurrent expenditures:

1) Distribution of teachers among Professors, Associate Professors, Lecturers, Assistants and Instructors. At the present time, Lecturers, Assistants and Instructors constitute a very large part of the teaching force. The number of Professors and Associate professors is very low. How does this distribution change from now to the horizon year? Of course this distribution affects salary expenditures because of the differences of salary between the various categories of teachers.

2) Change in the Instructional unit expenditures, in the Administrative unit expenditures and in the Student Welfare unit expenditures. How these various unit expenditures will vary between now and the horizon year?

3) Annual salary of the different categories of teachers. How salary will change between now and the horizon year? In varying the salary scale you may like to take into account the GDP per capita which obviously will change between now and the horizon year.

It would be useful to make several simulations using different sets of policy variables and see their effect on total recurrent expenditures.

At the present time, the percentage of GDP devoted to higher education is O.48%. Supposing that this percentage may reach 1% in year 2000, build alternative sets of assumptions satisfying this constraint.

What are the relative advantages and drawbacks of each alternative and how choice can be made among these alternatives?

Appendix A

PROGRAMME OF THE WORKSHOP

Tuesday 3 June		
8.00 - 9.00	Opening Ceremony	Wang Xian-Ming Zhao Yong-Kui S. Lourié
9.00 - 11.30	Objective of the workshop Teaching-learning methods	S. Lourié Ta Ngoc Châu
14.00 - 17.00	Research, technological Development and industrial development (Part I)	S. Lourié
Wednesday 4 June		
8.00 - 11.30	Research, technological development and industrial development (Part II)	S. Lourié
14.00 - 17.00	Industrial development, technology and the structure of qualified manpower (Part I)	H. Reiff
Thursday 5 June		
8.00 - 11.30	Industrial development,technology and the structure of qualified manpower (Part II)	H. Reiff
14.00 - 17.00	Training qualified manpower, the joint role of higher education and enterprises	H. Reiff
Friday 6 June		
8.00 - 9.30	The structure of the industrial sector	Ta Ngoc Châu Yip Hak Kwong
9.30 - 11.30	Practical exercise No.1 on the structure of the industrial sector	
14.00 - 15.30	Practical exercise No.1 (continued)	

15.30 - 17.00	Discussion on the results of exercise No.1	
Monday 9 June		
8.00 - 9.30	The structure of qualified manpower within the industrial sector	Ta Ngoc Châu Yip Hak Kwong
9.30 - 11.30	Practical exercise N0.2 on the structure of qualified manpower	
14.00 - 15.30	Practical exercise No.2 (continued)	
15.30 - 17.00	Discussion on the results of exercise No.2	
Tuesday 10 June		
8.00 - 9.30	The diversity of higher education institutions	B. Sanyal
9.30 - 11.30	Practical exercise No.3 on the distribution of enrolment and graduates by discipline and by type of institutions	
14.00 - 15.30	Practical exercise No.3 (continued)	
15.30 - 17.00	Discussion on the results of exercise No.3	
Wednesday 11 June		
8.00 - 9.30	Trends in new admissions and in enrolment in the various specialities of higher education	Chu S.K.
9.30 - 11.30	Practical exercise No.4 on analysis of past trends in the development of higher education in China	
14.00 - 15.30	Exercise No.4 (continued)	
15.30 - 17.00	Discussion on the results of the exercise No.4	

Thursday 12 June		
8.00 - 11.30	Process and actors in higher educational planning (Part I)	S. Lourié Cheng K.M.
14.00 - 17.00	Process and actors in higher educational planning (Part II)	S. Lourié Cheng K.M.
Friday 13 June		
8.00 - 11.30	Financing of higher education (Part I)	Cheng K.M.
14.00 - 17.00	Financing of higher education (Part II)	Cheng K.M.
Monday 16 June		
8.00 - 11.30	Building an information system for higher educational planning (Part I)	Ta Ngoc Châu Chu S.K. Yip Hak Kwong
14.00 - 17.00	Building an information system for higher educational planning (Part II)	Ta Ngoc Châu Chu S.K. Yip Hak Kwong
Tuesday 17 June		
8.00 - 9.30	Projection of qualified manpower needs: critical analysis of existing methods	Chu S.K. Yip Hak Kwong
9.30 - 11.30	Practical exercise No.6 on projection of qualified manpower	
14.00 - 15.30	Exercise No.6 (continued)	
15.30 - 17.00	Discussion on the results of exercise No.6	
Wednesday 18 June		
8.00 - 9.30	Projection of new admissions and enrolment in relation with manpower needs	Chu S.K. Yip Hak Kuong
9.30 - 11.30	Practical exercise No.7 on projection of enrolment	
14.00 - 15.30	Practical exercise No.7 (continued)	
15.30 - 17.00	Discussion on the results of exercise No.7	

Thursday 19 June

8.00 - 9.30	Estimating the resources required for the development of higher education	Ta Ngoc Châu Cheng K.M.
9.30 - 11.30	Practical exercise No.8 on estimating resources for the development of higher education	
14.00 - 15.30	Exercise No.8 (continued)	Ta Ngoc Châu
15.30 - 17.00	Discussion on the results of exercise No.8	

Friday 20 June

8.00 - 10.00	Evaluation of the course	
10.30 - 11.30	Closing ceremony	

Appendix B

LIST OF PARTICIPANTS

Provinces

Mr. CUI Binjian	Planning official, responsible for educational planning	Division of Planning and Finance Education Committee of Henan Province
Mrs. DING Jinling	Planning Official Division of Planning and Finance	Bureau of Higher Education Jiangxi Province
Mr. FENG Minquan	Deputy Chief, responsible for financing	Division of Planning and Finance
Mr. GU Chenjiu	Planning official	Division of Planning and Finance Bureau of Education Anhui Province
Mrs. GUO Xiaozhong	Planning official, responsible for educational planning	Education Committee of Wuhan municipality Hubei Province
Mr. LAI Lunshen	Planning official, responsible for educational planning and statistics	Division of Planning and Finance Education Committee of Jiangxi Province
Mr. LAN Xiuting	Division of Planning and Finance	Bureau of Education Shanxi Province
Mrs. LI Jinçai	Deputy Chief of Division, responsible for educational planning and statistics	Division of Planning and Finance Bureau of Higher Education Guangdong Province (Canton)
Mr. LI Shuxing	Official responsible for planning	Division of Planning and Finance Education Committee of Hubei Province
Mrs. LI Suçui	Deputy Chief of Division of Planning and Finance	Bureau of Higher Education Liaoning Province

Mr. LIN Yuanshen	Planning official, responsible for educational planning and statistics	Division of Planning and Finance Education Committee of Guizhou Province
Mr. LU Xifan	Deputy Chief of Division of Planning and Finance, responsible for educational planning and finance	Education Committee of Zhejiang Province
Mr. SHUI Hanleng	Head of Division of Planning and Finance, responsible for educational planning	Education Committee of Harbin municipality Helongjiang Province
Mr. SHEN Yongcheng	Head of Division of Planning and Finance	Bureau of Education Inner Mongolia Province
Mr. XU Jinfu	Deputy Chief of Division of Planning and Finance, responsible for educational planning and statistics	Education Committee of Jilin Province
Mr. YAN Junzhe	Chief of Division, responsible for educational planning	Division of Planning and Finance Bureau of Higher Education Shanxi Province
Mr. YANG Zhirong	Deputy Chief of Division	Division of Planning and Finance Tibet Province
Mr. YIAN Dong Yang	Deputy Head of Division of Planning and Finance	Education Committee of Hunan Province
Mr. ZHANG Cao	Chief of Division, responsible for planning, capital construction, financing, etc.	Division of Planning and Finance Bureau of Education Yunnan Province
Mr. ZHANG Changyou	Deputy Chief of Division, responsible for educational planning and statistics	Division of Planning and Finance Bureau of Education Gansu Province
Mr. ZHANG Ruchang	Head of Division of Planning and Finance, responsible for planning, financing, capital construction work	Bureau of Higher Education Fujian Province
Mr. ZHANG Su	Deputy Chief, responsible for educational planning and statistics	Division of Planning and Finance Bureau of Education Quinghai Province

Mr. ZHANG Zuojun	Deputy Chief of Division of Planning and Finance, responsible for planning and statistics	Bureau of Education Shandong Province
Mr. ZHOU Shuren	Head of Division of Planning and Finance, responsible for educational planning and statistics	Education Committee of Heilongjiang Province
Autonomous regions		
Mr. CUI Shixian	Deputy Chief of Division, responsible for educational planning and statistics	Division of Planning and Finance Bureau of Education Xinjiang autonomous region
Mr. GUO Chaodong	Planning official, responsible for educational planning	Bureau of Education, Division of Planning and Finance Guangxi autonomous region
Mr. LI Qincuan	Chief of Division of Planning and Finance of University	Ninxia University Ninxia autonomous region
Municipalities		
Mr. GAN Xuezuo	Researcher	Research Office of Higher Education Higher Education Bureau Beijing
Mr. HUAN Suming	Division of Planning and Finance, responsible for planning and investigation	Education Committee of Guangzhou (Canton) Municipality Guangdong Province
Mr. LI Zhixiang	Planning official for Educational Planning and statistics	Education Committee Xian municipality
Mr. WANG Luncheng	Planning official responsible for planning management	Division of Planning and Finance Bureau of Higher Education Tian Jing municipality
Mrs. YANG Lijuan	Planning official	Bureau of Higher Education Shenyang municipality

Mr. ZHANG Jichun	Deputy Chief of Higher Education Division	The second bureau of education Dalian municipality
Mrs. ZHANG Lan	Planning official	Division of Planning and Finance Bureau of Higher Education of Shanghai municipality

Others

Mr. GAO Shoufa	Official for planning and management of pedagogy	Management Institute for Cadre Dalian
Mr. LI Zhuam	Planning Office	Dalian University
Mrs. WANG Langging	Deputy Chief of Division responsible for educational planning and management	Bureau of Education, Ministry of Transportation Beijing
Mrs. WANG Zhuyi	Official	Office of Educational Planning State Education Committee

Appendix C

RESOURCE PERSONS

Unesco

International Institute for Educational Planning

Mr. Sylvain LOURIE, Director
Mr. TA Ngoc Châu
Mr. Bikas SANYAL

Division of Educational Policy and Planning

Mr. Hans REIFF

Regional Office for Education in Asia and the Pacific

Mr. CHU Siao Ky

State Education Commission

Educational Planning and Financing Department

Mr. XU Dun Huang
Mr. HAN Jin
Mr. SHANG Jiqun

Research Office for Educational Planning

Mr. PENG Weiping

Beijing Normal University

Mr. CHEN Zhong Wen

Consultants

Mr. CHENG Kai Ming, University of Hong Kong
Mr. YIP Hak Kwong, Hong Kong Census and Statistics Department.